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"THE MORE EXCELLENT WAY."

TREPHINING

IN ITS

Ancient and Modern Aspect.

BY

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"The harvest gathered in the fields of the Past, is to be brought home, for the use of the Present."—Dr. Arnold.

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TREPHINING

IN ITS

ANCIENT AND MODERN ASPECT.

TO

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ETC., ETC.,

CONSULTING SURGEON TO THE LEEDS GENERAL INFIRMARY,

THIS WORK IS DEDICATED IN

ADMIRATION OF HIS SOUND JUDGMENT AND SKILL IN SURGERY,

BY HIS FORMER PUPIL AND HOUSE SURGEON.

INTRODUCTION.

I THINK it will be admitted that at no period in the history of brain surgery has progress been more rapid than during the last two decades. Substantial additions have been made to our knowledge in every branch of this subject, "dawn has replaced empiricism, for seeing our darkness is being on the road to light."

More frequently have depressed fractures of the skull been treated surgically, basal fractures have been successfully trephined, whilst more firm is the conviction that fractures of the spine, associated with evidence of injury or pressure of the cord, should not be left to that frequent refuge of inadequacy, the *vis mediatrix naturæ*, but rather, that if the general and local symptoms point to lesions that can be removed or relieved by elevation or extraction of vertebral *débris*, or the opening of the sheath to lessen tension, this should be done by the use of the elevator and trephine.

All these changes may not be improvements in the best sense of the word; time and experience will surely separate that which is valuable from that which is useless. A careful weighing of the evidence at present obtainable may be advantageous. It is one of the functions of the literary worker to rescue valuable matter from oblivion, and to render it more accessible, and without any claim to literary merit, my hope may be that what has been to me a pleasure in its preparation, this *brochure* may be found not without its use. It is not, perhaps, to be expected that an historical work of this kind can abound in originality. I am indebted to the literature on the subject that has come within reach, in my attempt to make it of practical value, and I have endeavoured, where possible, to acknowledge my authority. No apology is needed for the frequent references I have made to American surgery; I cannot but admire the genius and assiduity of the surgeons of that country, nor can we grudge them a large share of the honour, for the great advances made in the department of brain surgery.

The opinion expressed by Thucydides in the beginning of his history—"But, judging from the evidence I am able to trust, after most careful enquiry, I should imagine that former ages were not great, either in their wars or in anything else,"—is so prevalent among physicians and surgeons

at the present day, that old writers are, I think, unduly neglected. Many books lie on the shelves, and much that is interesting remains unknown, from the widespread belief that our professional ancestors wrote nothing worth reading now. A little study of medical writers corrects that notion, and everyone who takes the trouble to read the works of the best men of past times will find much food for reflection in their observations, their arguments and their errors.

CHAPTER I.

THE EARLY LITERATURE OF THE TREPHINE, WITH ITS MODERN APPLICATION TO INJURIES AND DISEASES OF THE HEAD AND SPINAL CORD.

Injuries to the head are ever to the surgeon, of great practical interest, and have always held a high place in pathological research. It is a well-worn axiom which says:—"No wound of the head so trifling as to be despised; and few so serious as to make life despaired of;" and yet, on the mode of treatment, especially in depressed fractures of the skull, much has been written and said. Lines have been laid down, which have become venerable by age and usage, and hence are liable to be adopted as correct, without consideration as to their fitness according to an advanced science and extended experience. There is no subject which has created more diversity of opinion than the employment of the trephine.

As to what is the right thing to do—the prime wisdom is now, even more than in Milton's days:

> "Not to know at large of things remote
> From use, obscure, and subtle, but to know
> That which before us lies, in daily life."

The multitude of counsellors and the diversity of their convictions are so great, that a surgeon can find authority for almost every variety of opinion and practice.

It is no wonder that those who have lived to see the rise and fall of many theories and many systems, are tempted

to become converts to the doctrine of finality, and to consider it very probable *a priori* that whatever is new is, therefore, not true, and if by any chance it should happen true, it would certainly prove not to be new; but when this frame of mind grows upon us, it will be well to consider that our past was once a future, and had a more undeveloped past before it, and that the old ways have been led up to, by ways still older, and no doubt worse to travel upon. While it is much to be desired that in this, as in other cases where modern surgery seems likely to reverse the weighty opinion of those who have gone on before us, no change in practice shall be made hastily, it is impossible to write on this matter now-a-days without seeing that, owing to the introduction of antiseptics, and the lessening dread of operations on the skull and brain, the pendulum of opinion, which has for so many years swung in the direction of non-interference, is now coming back again towards the opposite view.

If these battles over the best method of treatment have often-times waged fiercely, and if not fought to a conclusion, they have certainly won glorious victories on behalf of humanity and the establishment of scientific truth.

When we consider the peculiar development of the bones forming the cranium, the special function assigned it, of protecting so important an organ as the brain, its peculiar adaptation during the various periods of life to that viscus, it is evident that in cases of injury, we are called upon to adopt a line of treatment for which there can be no precedent in surgical affections in other parts of the body.

Early History.—To the medical historian the antiquity of trephining has been a frequent topic for research. During recent years discoveries have been made in France and other countries, conclusively proving that trephining was practised by neolithic men, who inhabited Europe several thousand years ago. As these inhabitants were probably cannibals, and therefore we may conclude ignorant and superstitious, it is highly probable that it was their very superstition which led them to trephine the skull. Epilepsy and insanity were the diseases in which the operation was supposed to be done, and the operator had probably no better instruments than sharpened shells or flints.

At first, an incision was made down to bone, the flaps retracted, and an opening made sufficiently large to expose the membranes of the brain, as a short way out for the "demon in possession," which was the supposed cause of the affliction. M. Broca holds that trephining dates from very early history; he says:—

"By the oldest Greek medical writers, mention is made of it as a usual operation. In the time of Hippocrates it was applied only to traumatic lesions of the head, and appears to have been done with a circular trephine; but it seems that the operation was far more ancient, and was applied to the treatment of other head affections. Until quite recently trephining of a primitive kind was in use amongst some of the South Sea Islanders, for the treatment of epilepsy, insanity, and even headache, and the operation was done by scraping with a piece of flint or broken glass, when the latter was to be had from Europeans. In much the same way, and with similar instruments, the operation was done in the 'neolithic' or polished stone period, the age following the so-called quaternary, and preceding the bronze epoch. This period corresponds with the burial in dolmens, the use of agriculture and the employment of domestic animals, the making of hatchets of polished flint, though rough chipped flint instruments were still in use."

In examining a number of skulls of this period, Dr. Prunières and M. Broca discovered that the operation of trephining had evidently been done in two different ways and for two different purposes, one being surgical and the other posthumous. The posthumous operation was performed only on those who, in infancy, had undergone the surgical operation. It was evident that in nearly all cases the surgical operation had been performed on infants; and that the patients had lived many years was evidenced by the growth and development of the bone. But in many of the skulls which bore such signs, it was found that a number of pieces of bone had been chipped away from the edges of the orifice, and some of these either perforated for the purpose of suspension or otherwise shaped as amulets, were found. In explanation of these facts, M. Broca refers to the early idea that epilepsy, insanity, and even headache and low spirits were due to demoniacal possession. He

believes that the orifice was made in order to give exit to the evil spirit, and ever after the individual would be regarded as an object of peculiar sanctity. Hence, the pieces of bone around were taken, after death, to form amulets and charms, to drive away evil spirits. But still more remarkable was the fact, that in all the cases of this posthumous operation, a part, usually about a quarter, of the margin of the original orifice was left intact, and that into the skull were inserted amulets made from similar pieces from another individual. This, he thinks, not only indicates the belief in an existence after death, but that the person maintained his individuality, and therefore they would not rob him "in the other life of the glorious evidence of the operation he had undergone in his youth." This, as M. Broca states, is probably the earliest record of a belief in a future existence, if we may accept it as such. As to the operation, there seems to be evidence that it was always performed on the young, never on the adult, the instruments employed being too imperfect to allow of penetration of the hard adult bone. M. Broca tried the operation on a young dog, scraping with a piece of glass, and found that it was easy and not followed by any serious symptoms. Considering the class of case, the desperate nature of the operation, and the barbarous method of performing it, to say nothing of the after consequences—*e.g.*, hæmorrhage, blood-poisoning, erysipelas, the danger of injury to the brain, the want of proper nursing and bad hygienic surroundings—it is wonderful that any patient should have recovered, and yet incredible as it may seem, Dr. Prunières states that out of twenty skulls in his possession, nineteen exhibit indubitable signs of having recovered from the operation.

This discovery throws a very remarkable light upon the history of the earliest ages of mankind. It is curious that it should have been made at a time when trephining has been proved that it can be used with advantage in some cases of brain disease, not obviously due to surgical injury. If it were successful before localization of the functions of the brain was thought of, perhaps it will also be now, that the refinements of localization are realised facts; the majority of the holes were situate in the parietal region and over Ferrier's motor area.

In 1868 M. Prunières discovered in a large dolmen near Aiquiens, a skull of which a large part of one side had been removed. Many have been found in the cavern of L'Homme Mort in La Lozier and several in the grottoes of Baye. In a tumulus at Bougon, near Niort in the south of France, a trephined skull was found in 1875, and in the cloister of Guérin, on the Seine, near Paris, the skull of an old man was found with a trephined aperture, which was completely cicatrized. M. Chouquet discovered in a mound near Ecuelles specimens of both surgical and *post-mortem* trephining. M. Gassie discovered a trephined skull in a mound at Entre Roche, and another was found by M. Guigan at Etang-la-Ville. In 1878, M. Prunières found in Beaumes-Chaudes (La Lozier) more than sixty specimens of trephined skulls. In 1880 were found in some artificial grottoes near Baye, several crania of the neolithic age, of which two presented cicatrized perforations. An extensively diseased skull showing evidence of surgical trephining was found in a grotto of the neolithic period at Bray-sur-Seine.

In Germany a few examples of pre-historic trephining have been found. The skeleton of a girl, twelve years, was found in the grotto Bytchiskala in Bohemia. The skull bore unmistakeable evidence of *ante-mortem* trephining. A great number of trephined skulls have been found in the ossarium of Beinhaus at Sedle in Bohemia. This heap contains thousands of human bones. Many of the skulls contain perforations. Some evidences of trephining have been discovered in a Criquoian cave near Ziemerin in Poland. A skull was taken from a tumulus at Bogdauoff, Russia, in which was a perforation made undoubtedly during life. In Italy has been found a rondelle or amulet from the occipital bone, both sides of which were highly polished, but no trephined skulls have yet been found in that country. In Denmark, two surgically trephined skulls have been found, one in a dolmen at Boneby, and another in a dolmen at Nois in the island of Falster. A number of excellent examples have been discovered at Rokina in Algeria. A very interesting cranium was found in the grotto of Casa da Mouva at Penicher, which contained the remains of 140 persons of the stone age.

Thus, in nearly every portion of Europe, do we find the traces of races whose only history is that which can be read, but hesitatingly, and with many missing sentences, from their bones, and carvings, their weapons and utensils. Time will undoubtedly, through further discoveries, fill the gaps now so prominent in their disconnected record. Let us next consider for a few moments the character of these perforations, and the instruments, so far as known or surmised, with which they were made. The apertures in the skull mentioned at the beginning of this paper are remarkable for the smoothness of their sides, and their almost perfect circular circumferences. They have the appearance of having been struck out with a die. It is evident that no stone or flint instrument could have produced them. If the skull belongs to the stone age, as is very probable, the material used was undoubtedly obsidian, the utility of which has been recognised for ages. It was first described by Pliny under its present name, which it took from its discoverer, Obsidius, by whom it was brought from Ethiopia. It is a species of lava, and is in reality a natural glass, very hard and brittle, opaque in masses, but translucent in flakes or sections, and is still used in manufacturing pins, ear-rings, and like trinkets.

A very favourite method of accomplishing the trephining seems to have been scraping with a piece of flint or shell. This is the theory of Broca, who, in substantiation of it, presented to the Paris Society of Anthropology some skulls on which he had produced the counterpart of the stone age apertures by scraping with a piece of glass. The incisions of the Inca skull from Peru appear to have been made with some cutting instrument, something like an engraver's burin, and not with a saw.

There still exist a race in Algeria, called Kabyles, among whom the practice of trephining is still extensively used. They perform this operation for cranial fracture. The instruments are of the most simple pattern, and yet are all useful and well designed for the purpose. They consist of a razor, a serpette, one or two saws, some straight and curved elevators, and the burin or perforator. The perforator is whirled between the hands until a perforation is made. This operation is repeated until the portion of bone

The intended for removal is surrounded with these apertures. The saw is then used to connect them, and the elevator lifts the piece out. It is a point of honour to evince no suffering during the operation, and if the patient cries out, he is jeered at or beaten.

The subject of pre-historic trephining is one to which many archæologists have devoted themselves. First and foremost among them stood Paul Broca, the distinguished professor of medicine in the Paris "Ecole de Medicin," a senator of France, and a very eminent archæologist. His researches among the mounds and tumuli of France have been productive of much valuable knowledge relating to the pre-historic races, and his ingenious and logical theories have done much to elucidate the difficulties connected with the study of archæology. Other diligent workers in the field are M. Prunèires, M. Paris, M. Chouquet, M. Gassie, Professors Wankel and Virchow.

In America, the first recorded case of trephining before death appears in a skull taken from the Tuca cemetery in the valley of Yucay, Peru, and which surgeons on that continent regard as remarkable evidence of a knowledge of surgery among the Aborigines, and there seems no doubt of its ante-Columbian date. The skull was considered of sufficient interest to be sent to M. Broca, who submitted it to a critical examination. He says: "Upon the left side of the external plate of the frontal bone there is a large white spot, quite regular, almost round or rather slightly elliptical, forty-two millimetres long, and forty-seven broad. The outlines of this spot are not irregular nor sinuous, the surface is smooth and presents the appearance of an entirely normal bone. Around this to the edges, the general colour of the skull is probably browner, and is perforated with a great number of small holes caused by dilatation of the canaliculi. The line of demarcation between the smooth and cribriform surfaces is abrupt, and it is perfectly certain that the smooth surface had been denuded of its periosteum several days before death. It is thus in truth that denudations of the brain behave.

"In the denuded points the superficial layer of the external table, deprived of its vessels and thus deprived of life, undergoes no change and preserves its normal struc-

ture, while the surrounding parts, in undergoing t
of traumatic inflammation, become the seat of the ostitis. After considering the development of these perforations of the external table of the denuded surface, it seems to be impossible to admit that the subject could have survived the denudation less than seven or eight days. M. Nelaton, who examined the specimen, thinks he may have survived fifteen days.

"The trepanning was performed in the centre of the denuded part, but the four incisions which circumscribe the removed portion extend at their extremities to the very limits of the denudation. It is from this, certain that the separation of the periosteum was produced by the surgeon who performed the operation, for the denudation was more regular than it could be as the result of an accident, and presents exactly neither more nor less the dimensions and form necessitated by the operation done upon the bone. This operation consists of four linear incisions, two of which are horizontal and two perpendicular, the horizontal lines cutting the vertical ones at right angles, and sufficiently separated to include a rectangular portion of the bone, fifteen millimetres long and seventeen wide. The rectangular portion of the bone included by the lines was entirely removed down to the dura-mater, and the result is a loss of bone whose absolute extent corresponds very nearly to that produced by our circular trephines of ordinary size. At their middle part, the four incisions in the bone occupy its entire thickness, which at this point is six millimetres, and beyond the limits of the removed portion they become more and more superficial and terminate in a slight depression on the surface of the bone at the limits of the denudation. The width of the incisions is about two millimetres in their middle and superficial part. This width diminishes in the deep parts, so that the bottom of the cuts become linear; it diminishes in the same way in approximating the extremities of the incisions.

"There is evidently no resemblance between this mode of trepanning and that which has been known from time immemorial in European surgery. For what motive had this trepanning been performed? There is no fracture or fissure of external or internal table. We notice, it is true,

on the internal table several very delicate linear cracks, but these present all the ordinary characters of those produced by time, and which are found in the majority of old crania. There was then no fracture, and the surgeon who performed the operation could consequently only be governed by the functional troubles in diagnosing the existence of an intra-cranial lesion. Was this diagnosis correct? Did the operation succeed in evacuating a fluid poured into the cranium? I am far from affirming this, but am tempted to believe it. In truth, the internal table around the opening is the seat of a very different alteration from that which existed on the external table around the denudation. It is in patches the seat of little perforations which attest the existence of an ostitis, but this does not seem to have been the result of the trepanning, because it is not at all regularly distributed around the opening.

"These peculiarities are well explained if we suppose that there had been for some days before the operation an effusion of blood under the dura-mater. What astonishes me, is not the boldness of the operation, as ignorance is often the mother of boldness. To trepan on an apparent fracture at the bottom of a wound is a sufficiently simple conception and does not necessitate the existence of advanced surgical art, but here the trepanning was performed on a point where there was no fracture or probably even no wound, so that the surgical act was preceded by a diagnosis. That this diagnosis was exact, as is probable, or that it was false, we are in either case authorised to conclude that there was in Peru, before the European epoch, an advanced surgery, and this idea, an entirely new one, is not without interest in American anthropology."

Dr. Nott has suggested as a satisfactory reason for the performance of this operation, the probability of a punctured wound, one made by a small, sharp-pointed instrument, as by a bayonet or dirk without fracture, which often cause extravasation of blood within the cranium, violent inflammation, suppuration, delirium, coma, etc., a punctured wound followed by such symptoms would clearly indicate trepanning to a surgeon of our day—the operation too, would remove the whole of the injured bone, and leave no trace behind of fracture or of any other bone injury.

Dr. Robert Fletcher has carefully compiled the views of different archæologists on this subject.

"The difficulty of determining whether these perforations have been made before or after death seems to me to have been underestimated. The nature of the wounds (if the operation was done for fracture) must have been such as to have been often fatal, and the operation itself in those days of rude surgery must have been followed by a much larger death-rate than at present. Is it not then a fair presumption, or at least a possibility, that many of the operations, were made with the vain hope of averting death, which followed it by a few hours or even days? Repair in bone is slow, and the first traces of it would be tender and easily disintegrated cicatrices which would soon crumble away from the edges of a wound in a buried skull. How then can we make sure that those operations were made after death and not a day or so before?

"Broca did more than anyone else to settle the two fundamental questions of prehistoric trephining in Europe. He says that in the stone age young children were often trephined for internal maladies. This he called 'prehistoric surgical trephining.' The term 'posthumous trephining' he applied to certain cases which presented unmistakable evidences of having been operated upon both before and after death. Such a skull showed a cicatrix of the bones representing a part of the original opening, and an enlargement of that opening by cutting a part of it away, taking large pieces of bone which are used as charms. Nearer than that Broca did not go. And the great question, were these openings made for a therapeutic or religious purpose remains unsettled? The numerous specimens which have been found in Michigan suggest several inquiries. Many more prehistorically trephined skulls have been found in Michigan than in any other state in the Union. Illinois and Ohio come next in order in respect to the number of such discoveries. Either these States have made more researches than others, or the Valley of the Great Lakes contained a race of people who practised trephining, just as there is now a race in the North of Africa who practise it while the other population do not. The Kabyles of North Africa are, by some anthropologists, thought to be the

remains of the Phœnicians. They practice trephining as a purely surgical measure. Michigan has fewer mounds than any of the states in the great central basins of the United States. Everywhere these mounds have been opened and studied, and the results have shown very few trephined skulls outside of this region. The openings in all Michigan skulls, and in fact in all American skulls, have been near the ve tex. They have rarely shown any evidences of cicatrization, and for those reasons are generally believed to have been trephined for religious rather than surgical purposes. If they were made for religious purposes, I do not see why more of them have not been found, since religious observances are commonly practised by the masses. But a few of the skulls taken from these mounds have had the openings. Surgical trephining could in the nature of things, only apply to a few persons—those who were injured or diseased. The fact that the openings show no signs of repair, does not signify that they were not made for a surgical purpose, which was taken too late to prolong life until repair could establish permanent traces. The holes are so small that in the successful cases the openings would close entirely in a few weeks, leaving no trace which would be likely to be detected by the eye of men who are not skilled in pathological osteology. The writer believes that the specimens before him, both from the River Rouge, were trephined for surgical purposes, and that the valley of the Great Lakes once contained a race of people who practised surgical trephining."

The consideration of the subject of prehistorical trephining leads very naturally to another subject which is so closely allied to it as to be in reality but a branch of it, and which is only second to it in interest and ethnological importance. I refer to the cranial amulets and rondelles which have been unearthed so often from the very mounds which contained the trephined skulls. These charms, which are pieces of bone cut from the trephined skull, are found pierced with holes undoubtedly made for the purpose of more conveniently depending them from a string by which they could be attached to the person of the lucky possessor. It is the most generally accepted theory that the skull of a person on whom trephining has been practised was regarded

as possessing a supernatural power, and that to have on one's person a fragment of such a cranium, the fragment including at least a segment of the circumference of the trephined aperture, protects him from the disease that the operation was made to alleviate. Another theory is that the amulets have been cut from the crania for the purpose of converting them into drinking cups. The "refined enjoyment" as Robert Fletcher calls it of drinking from the skulls of enemies was a prevalent practice among the hardy Northmen of the middle ages, but the fact that the pieces taken from the prehistoric skulls were taken almost entirely from crania that had been trephined, and were so carefully taken out with a view of including a segment of the trephining opening, and also were pierced for convenience in stringing, would point to the idea that it was the removed fragment to which importance was attached rather than the skull from which it was taken. These amulets have been found in the greatest number in France, at mounds among the Seine and in La Lozier, and chiefly through the researches of MM. Pares, Broca and Prunières.

Professor Joly[1] says:—"In all times, and even in modern days, superstition, the faithful companion of ignorance, has been allied to medicine and surgery; in every epoch certain nervous diseases, such as convulsions, delirium, epilepsy and madness, have been considered either as sacred or as the indication of the possession of body and soul by demons or other evil spirits, hence the idea naturally arose of opening a door through which to expel them; hence also the mystic origin of trepanning practised upon the living subject. And as convulsions and epilepsy (a supposed sacred disease) are commoner in children than in adults, we find a large number of perforated or trepanned skulls among young people. The subject himself was considered to be beloved of the gods if he survived the operation and was cured of the disease. The bones of his skull were reputed to possess wonderful therapeutic properties; they counteracted witchcraft and preserved from disease. This was more than enough to cause our neolithic ancestors to

[1] "Man before Metals."

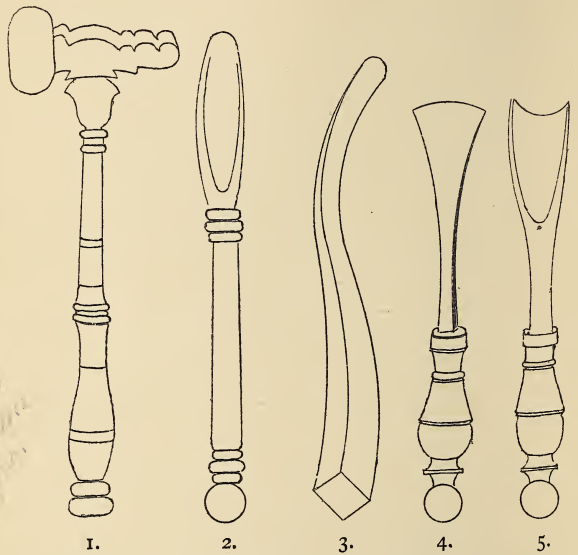
procure the trepanned fragments which were the object of their veneration and to wear them as amulets and precious talismans."

After the death of persons who had while living undergone surgical trepanning, a sort of posthumous trepanning was practised upon them, which consisted in taking from the skull circular pieces of fragments of various forms, taking care always to preserve on one of the edges of each piece a part of the cicatrized edge of the original opening. That was in some sort the authentic signature, the trade mark of the coveted talisman, which was thereby rendered so precious to the fortunate possessor. The healed edge does, in fact, exist upon nearly all the posthumous amulets, which proves beyond a doubt that the subject trepanned while living had long survived the operation. The edge is smooth, but it is distinguished from the remaining edges of the amulet in that the newly-formed bony substance covers the cells of the diploë, whereas the cells are visible in the other parts from the very effect of the polishing. The discs with polished edges were, it appears, fancy amulets, and are much rarer than the unpolished ones; both were, however, cut from the bone of the skull with a flint, knife or saw, at the celebration of the funeral.

We have said that the most skilfully wrought discs, those which were of most value, were found in skulls from which a great part of the outer bone had been removed by posthumous trepanning. They had evidently been purposely placed there. But M. Broca naturally asks what end these intra-cranial amulets were intended to serve; were they a symbol, a representation of the great portion of the skull removed by the operation of trepanning? It is hardly likely, since any fragment of a skull might have been employed for this purpose, and the precious amulet would not have been so lightly sacrificed. The intra-cranial amulet meant much more than that. It was a *viaticum*, a talisman which the deceased carried away with him into another life to bring him back, and to protect him from the influence of the evil spirits who had tormented his childhood. But even if we admit the first hypothesis, it none the less indicates the belief that a new life awaited the dead, for otherwise there would have been no motive what-

ever for the ceremony of restitution. The study of prehistoric trepanning and the attendant ceremonies prove, therefore, incontrovertibly, that the men of the neolithic age believed in a future life in which the dead retained their individuality.

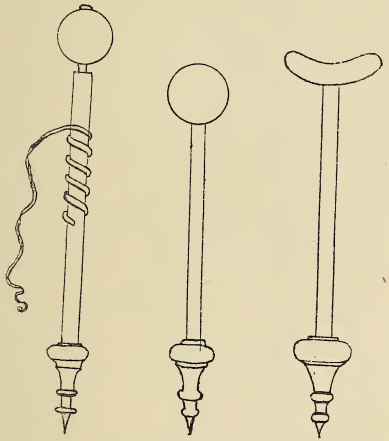
The early writers of surgery show us that extravasation of blood and the formation of pus between the skull and



1. Malleus plumbeus. 2. Cycliscos. 3. Meningophylax. 4. Scalper planus. 5. Scalper cavus.

the membranes of the brain were the two principal causes of bad symptoms and of death in fractures of the cranium, and that the only rational method of obtaining relief in either case was by making such an opening in the bone as would give relief to the fluids. Their intention and ours, therefore, were essentially alike, and the material difference between our treatment and theirs consists in the manner in, and the instruments by, which we endeavour to execute

such intention. If the breach in the bone was small, and no symptoms of immediate extravasation attended, their principal apprehension was, that the matter that they supposed must necessarily be excreted from the edges of the fracture, would drop down, lodge and be collected on the surface of the dura-mater. To prevent this evil they endeavoured to enlarge the fracture by abrasion of its edges, by means of scalpræ or rugines. These scalpræ were many in number, and various in their size and figure according to the opinion and whim of the surgeon. Figures



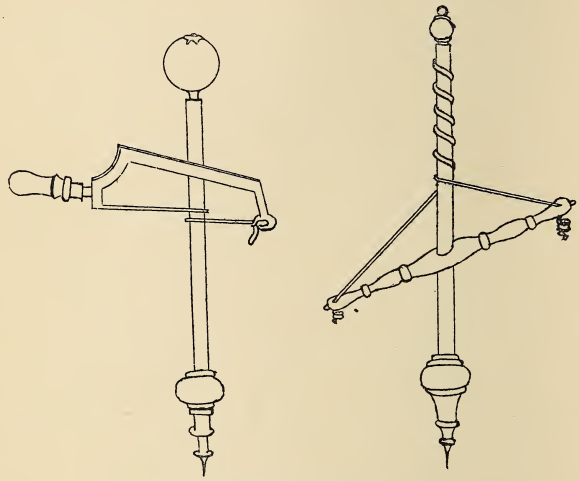
Guarded terebræ.

of these are to be seen in many writers—in Andreas a Cruce, in Scultetus, in Fabritius ab Aquapendente, in Beringorius, &c.

That by such kind of instrument the opening of a small fracture could be enlarged is beyond all doubt, but when the fracture was of such a size or so circumstanced that these scalpræ abrasoria would most probably prove insufficient—that is, if the accident was produced by such force, or attended by such degree of contusion, as to render it probable that the parts within were injured, they did not

then depend on this method of abrasion, but had recourse to others by which they remove a portion of the cranium.

Terebræ and terebellæ of various sorts, figures and sizes, the cycliscos, or scalper excisorius and a variety of modioli were invented and used for this purpose, figures of which may be seen in Vidus Vidius's Comment on Hippocrates de Velu. capit., in Peter Paaw on the same, in Andreas a Cruce's officina and others. The modiolus was a round iron instrument, hollow, serrated in its lower edges, through

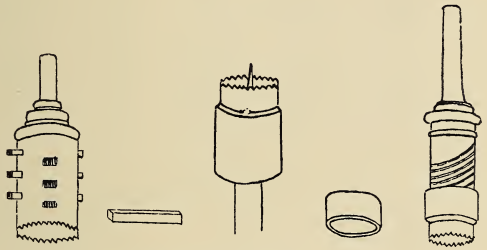


Guarded terebræ

the middle of which a pin was introduced, itself surrounded by a similar smaller inner circle—this instrument appears to have been the forerunner of the trephine.

If the piece of bone intended to be removed was larger than could be comprehended within the modiolus then in use and which was a very defective instrument in many respects, the operation was performed by means of terebræ (drills). There appear to have been, according to Celsus, two kinds of terebræ, one like that which carpenters use,

the other of a longer little head which begins from a sharp point, afterwards becomes suddenly broader, and again proceeds to another. The piece intended to be taken away was surrounded by perforations made at small distances from each other and then either the scalper excisorius or the scalprum lenticulatum was introduced, and by means of repeated strokes with a heavy mallet, was driven through all the interspaces between each perforation. By these means the portion of bone so surrounded was removed and the dura-mater laid bare. The tediousness which must attend the making of so many perforations, the disturbance given to the patient's head, the hazards of wounding the membranes



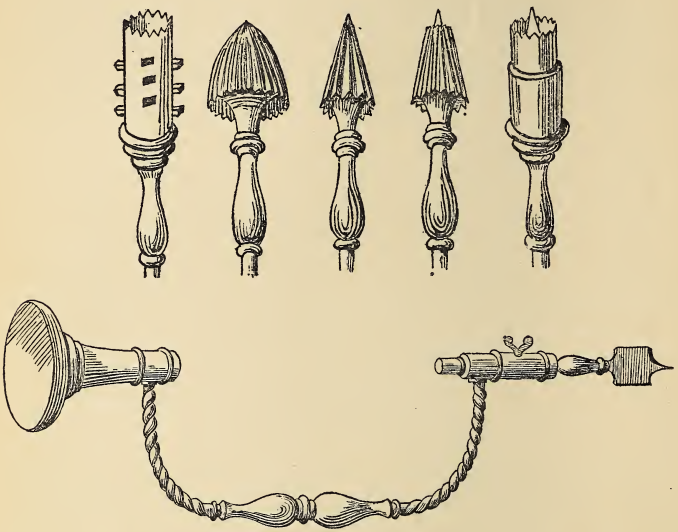
Guarded modioli.

of the brain, of most of these troubles and dangers they were sensible; they felt the inconveniences and dreaded the dangers so much as to run into great absurdities merely to avoid them. By some we are advised not to make the perforation quite through the bone, but to endeavour to leave a thin lamina of it entire. By others, to leave the piece, which the modiolus or terebra had surrounded adhering to the dura-mater, to be cast off by its suppuration, lest the hasty detachment of it should be mischievous.

The cautions laid down by Hippocrates and others concerning the part of the bone whereon to fix the instrument, and the great attention which they admonish the operator to pay to its execution, all proceed from the same fear. For the same reason it will be found that many of the best practitioners (Galen, Andreas a Cruce, Albucasis, Paul

Ægmet) endeavoured to furnish their perforating instruments with such guards or defences as should prevent them going too deep.

In Albucasis, in Andreas a Cruce, &c., are figures and descriptions of modioli, duabus, tribus, sel quatuor alis munati; of these, as well as of terebellæ, called abaptistæ,

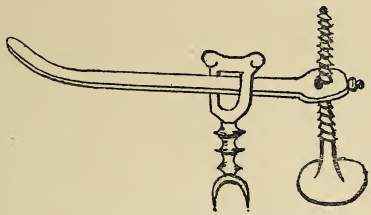


Drill stock fitted with terebræ, used for exfoliation of bone.—*Bell's Surgery.*

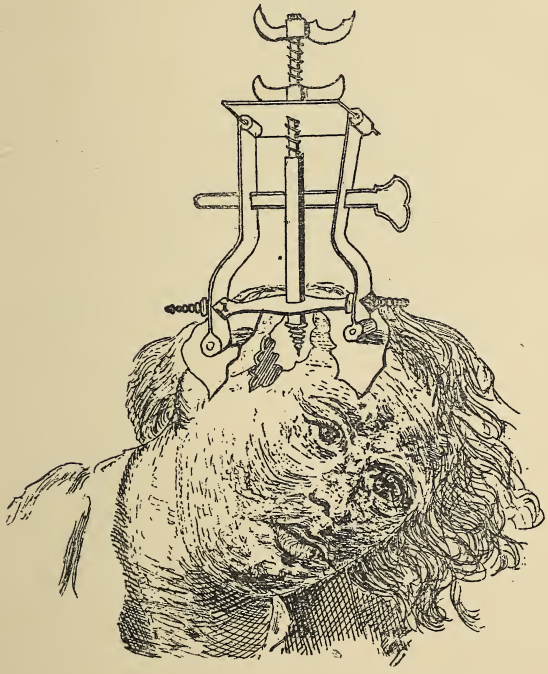
mespilatæ, torculatæ, &c., the number and variety of these is very large, although they are all formed upon the same principle, and all calculated for the same purpose, viz., to perforate the skull without wounding the membranes underneath.

An attentive consideration of what our remote ancestors have handed down to us on this subject may satisfy us that their observations on the appearances and symptoms of the ills attending this kind of mischief, was in general extremely

just and true, and their method of aiming at the relief was rational, but that the instrumental part of their art was so



1. Elevatorium simplex.

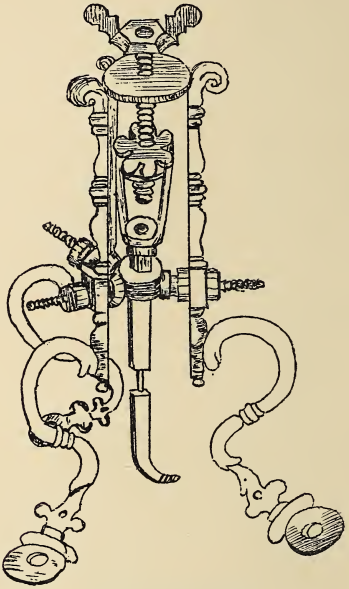


2. Trochlea bipes (*after* Pott).

deficient, and so unhandy, that they were not only in general prevented from accomplishing the good they in-

tended, but were not unfrequently driven into almost unavoidable mischief.

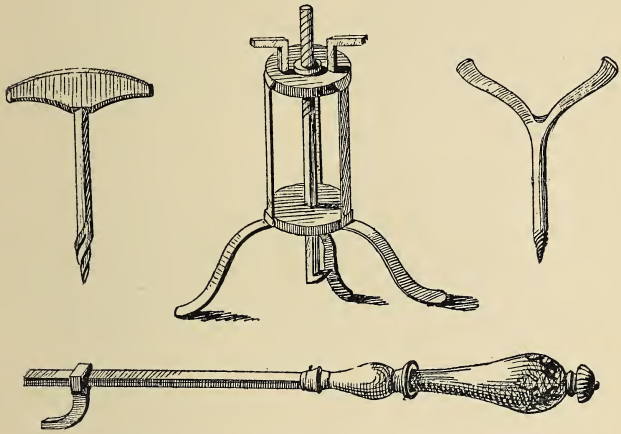
Pott tells us that most of the attempts made by our ancestors for the elevation of the depressed parts of the cranium were made by the application of instruments to



3. Trochlea tripes.

the part so depressed, and required some degree of force to be used in fastening them to such part. The trochlea tripes, the trochlea bipes, and all the pieces of machinery designed by Albucasis, Guido, Andreas a Cruce, Fabritius ab Aquapendente, Pare and Scultetus, as well as those delineated by Hildanus and Peter Paaw, are proofs of this—they all require a perforation to be made in the depressed piece, either by or for the screw with which it is to be elevated. Now,

not to mention that most of these instruments were so complex as to render them extremely unmanageable, it is obvious that by the application of any of them to the depressed pieces (especially if they were loose) all the ills arising from pressure made on the parts underneath must be increased, and that in many cases they could not be used at all.

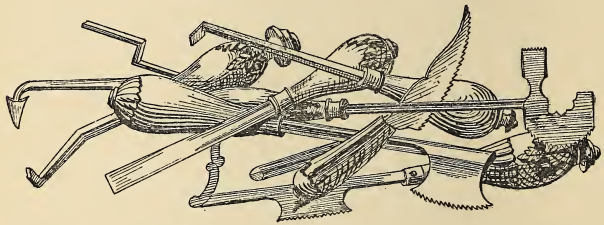


Antiquated forms of levators.

Celsus had indeed directed the meningophylax to be used as an elevator, which instrument differs but little from the elevator used at present, either in form or manner of application, but then the opening through which it was introduced is to be made either with the terebra or the cycliscos ; in short, all the objections which the old perforating instruments were liable to in simple undepressed fractures being of still greater force in fractures with depression.

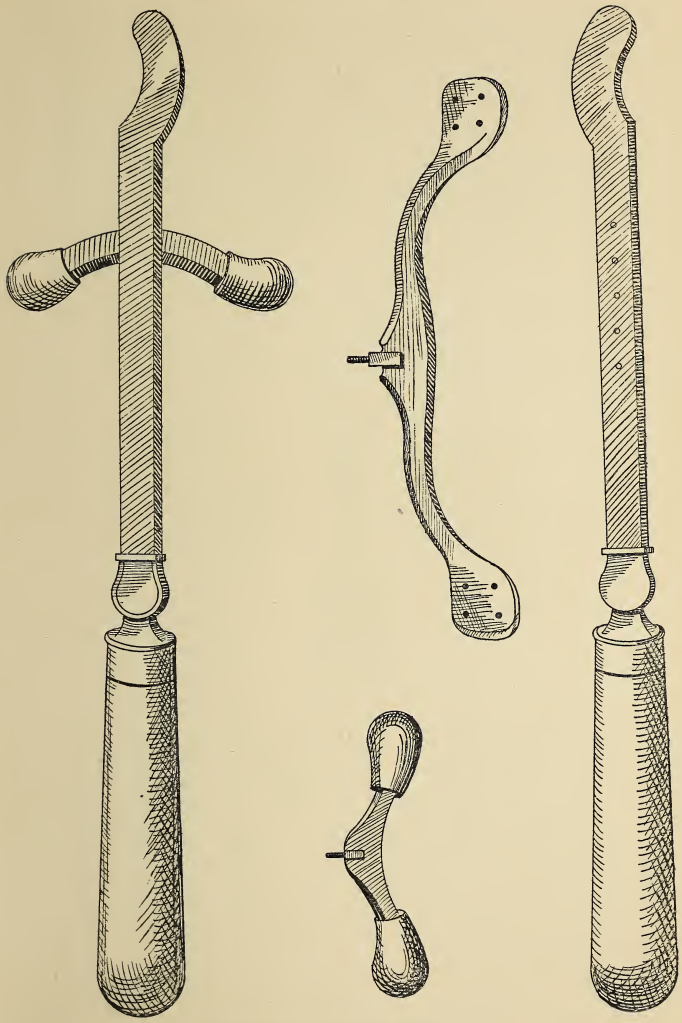
The majority of the instruments with which the cranium was perforated were contrived to make way for the admission of others, even the modioli which were used were so small in the diameter of the saw as to take away only a very small piece at each application.

M. Petit in 1750 communicated to the Royal Academy of Surgery at Paris, a description of a new elevator plate, with reflections on those hitherto used. He says the instruments hitherto used to raise the bones of the cranium depressed on the *dura-mater* are principally, the common elevator, the claw or the griffin's foot, and the triploid with or without the terebra, and sometimes the terebra alone. The triploid has three feet or branches like a tripod ; these rest on three points at small distances with the wound under the vault or arch formed by them. The moving force was applied with a nut, which received the screw of the upper end of an upright shaft, whilst the lower part had an extremity bent in the form of a hook, which is introduced under the bone to



Saws, rugines and pointed instruments of various forms for scraping and widening fissures and fractures.—*Bell's Surgery.*

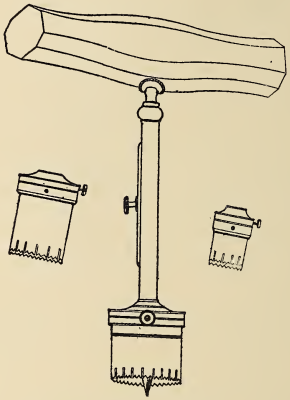
be raised, so that by turning the nut to the right the screw is gradually raised. It was an instrument that could hardly be used except by operators of great dexterity, and was therefore rarely used. These reflections induced him to contrive an elevator to which is attached a kind of bridge laid on the cranium for leverage and to which it was screwed. The lever was eight inches long, five lines broad and two thick ; the distal end grooved in front, the under part rounded and polished, that it may not wound the dura-mater. The surface of the under part had several holes in the middle, made lengthways, wormed, and served to receive a screw which bound and fixed the lever fulcrum. The second part of the elevator is like the bridge of a violin, and when fixed on the cranium only touched on its two



M. Petit's levator and fulcrums.

extremities. At the top of the bridge is the screw before mentioned, which when fixed in the screw holes fixes it to the lever. The bridges are made in several sizes to be used in the different cases which may occur in practice.

With regard to the inventor of the trephine and how it received its name I can say nothing definite, it is probably the outcome of the trepan (trephine, diminutive of trepan, from the Latin trepanum, Greek trapanon, τρυπαω, to bore). It was first made with the handle of iron, the extremity of



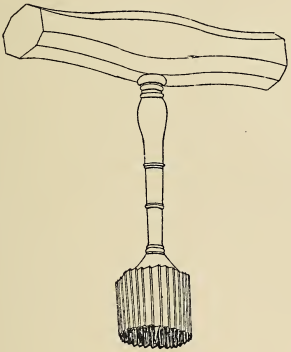
The trephine of to-day.

such handle formed in such a manner as to serve the purpose of an elevator, thus combining, as it were, two instruments in one. This, Mr. Pott thought a great fault, because it added to the weight of the instrument, and that in a wrong part of it, and thereby rendered it less manageable. He recommended that the handle should be of light wood, not too long, and of an octangular shape, and that from the figure depicted in his work with slight modification, is the trephine of our day.

Mathieu's trephine is a useful little instrument, much smaller than the one formerly used; its action also is more reliable and regular and less sensitive to shocks.

It may be interesting if I endeavour to throw some light upon the manner in which the earliest writers were wont to make their incisions, in laying bare the skull previous to the operation and their subsequent treatment of the dura-mater (for this information I am largely indebted to a little work by Robert Mynors).

Hippocrates, B.C. 400, gave no particular directions for the incision of the scalp previous to the use of the terebra, but in speaking of wounds of the head where the bone has been denuded, he directs[1] the incision to be made in the



Pott's trephine.

superior part, sufficiently large to ascertain whether the bone be injured and to separate the flesh from the bone, further observing that the section of the parts for this purpose ought not to be made on the temples nor above the temporal artery—for convulsions on the opposite side would be set up. In cases where the injury seems to require perforation we must have recourse to it within three days, and recommends where the dura-mater is denuded, that it should be cleansed and exsiccated as soon as possible lest it be kept moist too long, it becomes spongy and rises into a fungus or putrifies.

[1] "Hippocratis Opera, edit. Charlerii lib de Vuln."

Celsus,[1] A.D. 30, followed the Hippocratic method, which for four hundred and sixty years had been practised almost without change. He recommended the wound to be enlarged till the injured part appear, and that none of the peri-cranium be left on the bone, for that when lacerated by the scalprum or terebræ would excite violent fever with inflammation. If there be a wound it is necessary to dilate in the course of it, but if we are to make one that form is generally most convenient, which by two transverse lines gives the figure of the letter X that the scalp may be afterwards raised up from each angle. After the operation he directs the dura-mater to be sprinkled with sharp vinegar, that if there be any hæmorrhage it may be suppressed, or any coagulated blood remain within it may be dissolved; if the dura-mater puff up by inflammation, tepid oil of roses should be poured upon it. When things go on well he observes that granulations spring up from the dura-mater and from the diplöe of the cranium, filling up the vacuity of the bone, and sometimes even to grow above the bone, but when that happens it is to be sprinkled with squamæ æris to suppress and restrain it, and to use such other dressings as will produce a cicatrix.

"Salvianus mentions a lunatic who by accident had the skull broken and was 'exceedingly cured,' and another, who, breaking his head from a fall from on high, was instantly recovered from his dotage; Gordonius recommended 'the head to be shaved and bored to let out fumes which without doubt will do much good.' I saw a melancholy man wounded in the head with a sword, his brain pan broken; so long as the wound was open he was well, but when his wound was healed his dotage returned again. Guianerius cured a nobleman in Savoy by boring alone, leaving the hole open a month together, by means of which, after two years' melancholy and madness, he was delivered." (Burton.)

Heliodorus[2] wrote that he did not use one method only of incising the soft parts, but adapted it to the form and nature of the fracture, for sometimes in a fissure, he says, a simple incision is proper, but he mostly used that form which by

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[1] "Celsus de Medicina." Ed. Krause.

[2] "Heliodorus de Fracturis, ex. Nicetana collectione per Cocchium."

two transverse lines gives the figure of the letter X. After the perforation, he gently wiped off what little blood there may be left on the dura-mater with a probe armed with wool and dipped in oxycrate, then dropped oil of roses on the membrane, and afterwards lint moistened with oil of roses under the separated parts, and longer doubled pieces dipped in the same oil between the lips of the wound, directing the doublings of the lint to be turned inward and their ends outward, lest they touch the membrane.

Galen,[1] A.D. 200, the great Roman physician, although of oriental origin, as a great genius, was capable of giving a great breadth of view to any object which he might take in hand. He was probably educated at Alexandria and Pergamos, and from his writings it is evident that an immense advance was made in medicine and surgery particularly as to the nervous system during his epoch. Galen held that it was necessary to remove somewhat of the fracture that we may be able to deterge and wash away the sanies from the dura-mater; afterwards, when the first inflammation is over, he advises dry dressings to produce flesh and cicatrize the wound. He asks a pertinent question—what is the principal intention of all our medicaments and care after the perforation of the bone: whether should the treatment consist of lenient and mitigant applications which are now mostly used, or of very drying medicaments? The latter of which Meges Sidonius approves, and Eudemus, an old experienced practitioner, a citizen of ours, always used, viz., a plaister called isis, to be applied immediately to the dura-mater, and over that, oxymel, but I have never seen any other person use them, nor dare I. I can only testify for Eudemus that more were cured by him than by those who used lenients. Galen decides in favour of the drying medicaments, from reasoning that the meatus auditorius, which not only communicates with the dura-mater, but with the nerve sent to it from the brain, will bear very active medicaments, nor is it, therefore, to be wondered at if the dura-mater, which is naturally of a dry texture, will, when exposed, before it becomes much inflamed, bear very powerful applications.

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[1] Galeni Method: Medenti lib.

Paulus Ægineta (A.D. 640) lived in the seventh century both at Rome and Alexandria. He has been esteemed the most eminent surgical writer amongst the ancients. He directed after the hair is shaved off, to make two incisions at the wound intersecting each other at right angles, like the Greek letter X, one of which should be in the direction of the wound, then to separate the four angles in the middle that the bone which is to be perforated be totally denuded, the dura-mater to be dressed with linen dipped in oil of roses.

Rhazes, who was born about the middle of the ninth century, recommended in fracture with depression the speedy extraction of the fractured bone, cautioning the operator against injuring the dura-mater in the operation, and advising it to be done before symptoms of danger appeared.

"In the chaos which followed the fall of the Roman Empire, and in the unusual transmigrations of peoples which accompanied that general disintegration of the then civilised world, we are quite prepared to learn that like all other forms of knowledge, scientific investigation practically ceased, and, indeed, only received cultivation again after a powerful race had once more succeeded in constituting itself out of the general ruin. This, relatively speaking, was first accomplished by the Arabs, but dissection was considered incompatible with Islamism, and consequently up to the tenth century we find no advance made from Galen's time into the mediæval epoch, which we may take as beginning with the tenth or eleventh centuries." [1]

Albucasis, a Spaniard of the eleventh century, Alricemia Brunus, a Calabrian, and the Persian Haly Abbas, all followed the directions of Paulus Ægineta, and also after the perforation of the bone by the terebellum, applied oil of roses to the dura-mater.

Rolanus (A.C. 1240) also recommended the crucial incision of the scalp and to separate it from the cranium with the rugine, and dressed the dura-mater with fine old linen or silk which he prefers, and then filled up the external wound with linen dipped in the white of egg.

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[1] Victor Horsley.

Lanfrancus (A.D. 1270) preferred triangular incisions made thus ▽, by means of which he made only one flap of scalp in denuding the bone.

Guido (about 1360) recommended the operation to be performed as soon as possible in cases of great compression and in which the dura-mater is punctured to avoid posthumations, &c. He used the crucial and triangular incisions, and dressed the wound with honey and oil of roses, placing a little of this mixture by the end of a probe between the bone and the dura-mater to preserve the membrane from being injured by its motion against the bone.

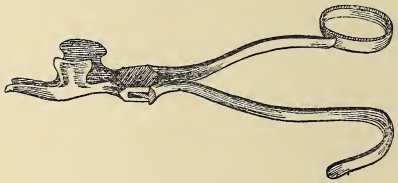
Bertapalia (A.D.1417) approved of the triangular or quadrangular incision of the scalp with the removal of the pericranium. When a portion of the cranium is removed he applies the yolk of egg mixed with warm oil of roses, fills up the wound with dossils dipped in the same medicine, and anoints the adjacent parts with warm oil of roses, filling up the wound until digestion appears, over which, having the part first shaved, he applies his digestive ointment called Ungentum de refina pini, and over the whole a betony plaister ; after digestion is completed, he dresses with honey of roses alone, esteeming the dura-mater and cranium to be of a dry nature.

Berengarius Corpensis (1535) learned anatomy in France and afterwards taught it at Morburg, favoured a triangular or quadrangular incision.

Marianus Sanctus (1539) recommended the triangular or crucial incision and to remove the pericranium from the bone. Fallopius, who lived beyond the middle of the sixteenth century, was the founder of what has been named the Italian School. He taught his students to make a simple incision, beginning from the inferior part and carrying it upwards, and if it be not sufficient, he preferred the triangular form, the pericranium to be cut and denuded with the nails.

Vesalius (1564), who was born at Brussels, was chief physician to Charles V. and Phillip II. He taught the same method of incising the scalp and separating the pericranium from the bone as Fallopius had done. He was drowned on his return from a pilgrimage to Jerusalem, which was imposed upon him because he was believed to have opened the body of a young nobleman before he was dead.

Andreas a Cruce (1596) held that if the size of the wound be not sufficient to expose the fractured bone it must be enlarged, but if we are to make a wound he recommends it to be done in the form of the letter X. He further remarks: "The incision commonly called crucial should be made only in case of a large fracture or great depression of bone, otherwise the triangular, or that in the form of the letter ≺ or ⊣, may be used; and if on account of the size of the wound and the straight direction of the fracture it can be dilated and its lips somewhat separated, there will be no need of incisions, the pericranium must then be separated immediately from the bone, either with the finger nail or a blunt-edged instrument; the lips by these means will be equally distant from each other, so that the fracture may appear, and the operation be conveniently performed." His application to the dura-mater after the operation is warm oil of roses.



Dilating forceps.

Quercetanus (1600), speaking of injuries to the head without a wound of the scalp, observes that a wound should be cut with a knife, *decussatim*, sufficiently large for the necessary operations. To the dura-mater he applies a red silken sindon dipped in a mixture of two parts of mel. rosarum and one part of ol. luteorum ovorum made warm.

Peccettius (1616) agreed with Celsus Paulus and others that the incision should be made in the form of an X or +, in such manner that the wound make one of the lines. The pericranium is to be separated from the skull, that the injuries of the bone may be seen the better, and lest it be torn in operating, which would produce pain, inflammation, fever and death. His treatment of the dura-mater con-

sisted of suppurantes till digestion is completed, then detergents and exsiccants, to be varied according to the constitution of the patient, the season of the year and the state of the wound.

Fienus (1631) tells us that in his time in a case of fracture without a wound the crucial incision of the scalp is mostly used, but sometimes the triangular incision was employed, viz., that the sutures and some blood vessels might be avoided; then the pericranium was removed from the bone by an obtuse instrument or the back of the knife so that the angles of the scalp might be raised. He says there is another method of denuding the cranium by which the skin is not cut but burnt, either by the actual or potential cautery. The actual cautery used for this purpose, he informs us, is a cylindrical sharp-edged instrument in the form of a canula. When it is used it is to be placed upon the scalp to burn it down to the bone; which done, that part of the scalp included within the cautery is to be torn away from the bone, which must be fairly denuded. This method of denuding the cranium, he says, has many advantages: (1) it leaves no angles of the skin to obstruct trepanning, but only makes a round foramen; (2) it averts all danger of hæmorrhage from the division of any artery, for the cautery in its operation closes the arteries so that it is very convenient when there is danger of hæmorrhage. (3) Its chief advantage is, when there is a necessity of trepanning immediately, as when the operation has been too long delayed, or there may be danger of procrastination; for when this method is used you may proceed to the operation of the trepan immediately, which cannot be done when the scalp is cut, for then it requires a delay of one night at least, and often two or more if the recent wound should bleed again. The fourth advantage is, that from the operation of burning, and the skull being made hot, the fibres of the dura-mater adhering to the skull within will perish, and thus may the piece of bone taken out by the terebra be separated and removed without violence. He dressed with honey of roses, and further remarked that the foramen in the skull is closed up by new flesh, and that no new bone supplies the place of that which may have been taken away; but granulations shoot up, partly from the dura-

mater, partly from the skull, and partly from the lips of the wound, and when all are joined together, the foramen is filled up with flesh, which in time becomes callous, and often defends the brain as well as if new bone had been generated.

Bannester[1] directs an incision to be made in the scalp in the form of the letter X, and to uncover the bone. After the perforation of the skull he dresses the dura-mater with honey of roses on a red silken sindon, in the usual manner, with digestive to the lips of the wound.

John Woodhall[2] observes that "the incision of the scalp is either to be made directly crosse or in the forme of this Romane T, and when the cut is divided, together with membrana carnosa, or fleshie membrane, the pericranium, or pannicle covering the skull, is also to be taken away that the fractured part be bare." His dressing to the dura-mater after the operation is "the noble liniment of Arcaeus, never sufficiently commended, and, being somewhat hotter than the partie would willingly beare it ; anoint the wound therewith in each place, with a little soft lint on a probe's end, leaving the said lint therein, and with pledgents of lint drie, fill up the orifice."

Peter Lowe[3] advised "an incision of the flesh to the pan, in forme of St. George's crosse, then to separate the crane from the pericrane, putting lint or caddie to dilate the wound." At page 319 he says: "If the dura-mater be inflamed or in any wise altered, as often happeneth, and is most dangerous, for which we give glysters and draw blood, and use fomentations in the place of anodines and repercussives."

Felix Wurtz[4] recommended "to lance the skin crossway to the skull, in the breadth of half-a-crown, and put back the four pieces that the skin be naked." In treating the dura-mater he says: "My advice is not to use any powders, waters, oyles, salves which some do make and apply them to the skull and the dura-mater, for I marvelled

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[1] Bannester's Works, published in 1633.
[2] Woodhall's "Military and Domestique Surgery," 1639.
[3] Peter Lowe's "Surgery," 1654.
[4] Felix Wurtz's "Surgerie," translated by Fox, London, 1656.

much that in this particular, nature was not better regarded, whereas neither the skull nor the brain can endure anything."

Petrus De Morchettis, of Amsterdam, 1665; Jobus A. Meekren, 1682, of the same place; Hildanus, of Frankfort, 1682; Munnicks, 1689; Scultetus, 1697; Muys, of Amsterdam, 1695; all used the crucial or triangular incision, and dressed the dura mater with red silken or white linen sindon, with the mel or oil of roses, with dossils of dry lint over it.

At this time it was considered expedient to raise every slight depression, as Bell[1] says: "The passion for raising depressed bone, even those slight dimples of which the skulls of children are so susceptible, gave occasion to the most puerile and ludicrous inventions." Hildanus toiled in this occupation; he invented various plasters, which being laid upon the head of the child, with a string in the centre, operated like a boy's sucker fastened to a stone—by pulling the string you raised the depression. Next he invented a sucking horn, which he has very carefully delineated; which, being applied like a cupping glass, and sucked by a man of strong breath, raised the depression, and finally he directed that the child should strain its own breath, or that if it would not or could not do so, you should close its mouth and nostrils and hold in its breath to assist the external suction.

Thus the surgeon allowed not the slightest chink, fissure, or rima, as they called it, to escape investigation. The slightest fissure, or the bare suspicion of one, was the signal for applying the trepan, and there was nothing so gratifying to them as a fracture so circumscribed, or an extravasation so extensive as to require, or at least to vindicate, the application of the trepan ten or twelve times. According to Stalpart Wander Weil, in his observations, there had been injuries to the head where it had been necessary to apply the trepan twenty-seven times; which is corroborated by the ever memorable operation performed in the time of King William's wars on Philip, Count of Nassau, by Henry

[1] John Bell's "Principles of Surgery."

Chadborn, chirurgeon. Godifredus, chief surgeon to the States of Holland, mentions this operation performed by his friend, who trepanned the Count's cranium twenty-seven times, and ascertained the fact by the most indisputable authority, for he made the said Count of Nassau, after he had recovered on the 12th day of August, 1664, write the following curious certificate:—"I, the under written Philip Count Nassau, hereby declare and testify that Mr. Henry Chadborn did trepan me in the skull twenty-seven times, and after that did cure me well and soundly."

Wiseman[1] taught that when "the symptoms do demonstrate that there is a fracture or fissure, you are then, without delay, to open the hairy scalp, according as the part will admit, angularly, or in the manner of a cross, or of the letter T, that the fracture may be discovered by the raising of it up, with its pericranium. For if you shall in doubtful fractures or fissures make a round incision and take out the whole piece; then, if there chance be no fissure, you have made yourself a long work to little purpose, and if the fissure run under the hairy scalp further than you made your incision, you may then be necessitated to cut it open that length, by which it will appear you have, through mistake, laid it open more than necessary in one place, and too little in another, doing that which neither Hippocrates nor any judicious chirurgeon would ever allow; whereas, if you had laid it open by a cross incision, you might, by only raising the scalp, have discovered the fissure or fracture, and if yet part of the fissure or fracture had lain undiscovered, you might have stretched your incision to it; and in case, after all, there had been no fracture or fissure, which often happens, especially in contra fissures, then you might have laid the hairy scalp down again and easily cured it; which by an incision of part of the scalp, you cannot do. As to what may be objected, that the raised-up lip might be troublesome to the chirurgeon in his work, and painful to the patient; there is no such thing, for if the incision be made the way proposed by the antients, and that the fracture or fissure be all in your view, you may order the lips as you please." At page 373 he says, "In order to proceed

[1] Wiseman's "Chirurgical Treatises," London, 1697.

to the perforation of the cranium, the bone must be cleared of its pericranium, lest in setting on the terebra or modiolus, you tear the membrane." After the operation he advises the use of lenients to the dura-mater, observing in common cases after recent terebrations that resin, by its emplastic quality mixed with oil of roses, perfects the concoction soon, and by its anodyne quality secures the part from inflammation; he further directs these medicaments to be applied to the membranes upon a sindon, and over that soft dossils of lint to fill up the void space in the bone, thereby to keep the dura-mater from rising above it.

Belloste[1] says he will pass over the operation of trepanning in silence, as nothing extraordinary hath therein occurred. At page 77 he says, "When the dura-mater is uncovered I propose a plate of lead, very thin and smooth, pierced into holes in several places, without any inequality, cut and fitted to the bigness of the opening, and to make it more exact I sketch it out with the crown of the trepan that I have used, or am to use in this operation; or its measure may be taken from the piece of the skull cut out by the trepan. On each side of the plate is left a little ear, somewhat longer than the thickness of the skull; these little ears I bend both one way, so as they be perpendicular to the plate, and so much of them as exceeds the thickness of the skull I bend outwards again, that thereby they may rest upon the skull, and by which, as by two little handles, I may lift them up with pincers, if needs be, at each dressing; these two little handles may be cut somewhat broader than the two pieces that join them to the plate, which must be of an equal breadth. When I use it I dip it in some proper medicine, pretty warm, and apply it upon a very soft pledget of fine lint." He then describes a five-fold advantage from the use of the above mentioned plate, viz.: (1) it facilitates the exit of matter or blood from within the skull, and which is imbibed by the lint; (2) it produces this effect by lengthy pressing on the dura-mater; (3) it prevents the formation of fungus; (4) it prevents the dura-mater from being injured against the edges of the perforated bone; (5) it defends the bone and its membranes from the access of

[1] "Belloste, Hospital Surgeon," 3rd edition, London, 1715.

air, and supplies in some measure the part of the bony substance removed.

About this date, on the Continent, Juncker,[1] in his chapter "De Trepanatione," speaks of three forms of incision then in use, viz.: the crucial, or the form of the letter X; the letter T; and the triangular, or the form of the letter V. He orders the incisions to be made with a firm and steady hand, so that the portion of the scalp which is to be cut, be divided together with the pericranium at one stroke, unless we suspect, or in cutting, apprehend the fractured bone to be broken into many pieces. Where the pericranium is not equally divided by the first incision, let it be afterwards cut with greater circumspection. After the operation, he says, the dura-mater is *to be particularly dressed with good balsamics, applied on lint*, avoiding oil or acrid applications; the essence of amber mixed with a small quantity of the essence of myrrh is commended for this purpose. A small quantity of the spirit terebenthinæ may be added to the above, but not too much, as it may endanger inflammation and copious suppuration.

Turner[2] observes that some propose the incision to be made in the form of the figure 7, others, like that of the letter V; some in a semi-circular and others in a circular, taking out the piece. In another place he says:—"The incision in the form of a cross or in other forms may be advantageous, through the scalp to the bone, with a removal of the pericranium." He dressed the wound in the usual manner with honey of roses. In vol. ii. he says:—"There is nothing better than the warm liniment of Arcæus or Wiseman's medicine, composed of oil of roses and rosin for the first dressing to the dura mater."

Le Clerc[3] recommends the same incisions as Turner, and his dressings were sp. vin. and mel. rosar mixed upon a linen sindon.

Nuck[4] ordered the integuments of the cranium to be cut with a knife, unless there be a wound already made in a

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[1] "Johannis Junckereri Conspectus Chirurgiæ," Hala, 1721.
[2] Dan. Turner's "Surgery," London, 1722.
[3] Le Clerc's "Complete Surgeon," London, 1827.
[4] Anton. Nuck. "Operat. and Exper. Chirurg.," Lugdin, 1733.

simple line, or in the form of a cross or triangle, avoiding as much as possible the temporal muscles and the sutures. The lips of the wound are then to be separated and the pericranium perfectly scraped from the cranium with the separatorium of Solingen. He ordered the dura mater to be dressed with a sindon dipped in mel. rosar. et pauxil. spir vini, to be continued till all the humours are evacuated and the symptoms vanish. He sprinkles cephaligic drying powders upon the bone and dresses the rest with digestives.

Sharp[1] says:—"The manner of treating a fracture of the cranium will be according to the nature of the fracture itself, and the injury of the scalp—if the wound of the head be torn into angles, perhaps cutting off the lacerated flaps may make room for the saw; if the bone be broken into several pieces, the pieces may be taken away with the forceps, or if some of the skull be also depressed, the removal of the pieces will, without perforating, make way for the elevator to raise the depressed part; but if the fracture be not complicated with a wound of the scalp, or the wound is too small to admit of the operation, which seldom fails to be the case, then the fracture must be laid bare by taking away a large piece of the scalp. It is the fashion of some surgeons to make a crucial incision for this purpose, which they prefer to the other method, upon the supposition that the wound will more easily heal again after the operation by turning down the flaps, and in case we find no fracture, which sometimes happens after scalping, that by making this species of wound, an exfoliation of the bone and tediousness of cure will be avoided; but whoever has seen the practice of the crucial incision, must be sensible of the false reasoning which is used in its favour. . . ." He later says:—"I think it is indispensably right at all times to take off the scalp when we lay bare the cranium with a view to the operation, which seldom fails to granulate with flesh in a few days, if dressed only with dry lint, and rarely grows carious. . . . The form of the piece of scalp taken away may be nearly circular, and to be better assured of the course of the fracture, it will be proper it should be of the whole length of it. When the scalp is removed the

[1] Sharp's "Treatise of the Operations of Surgery," fifth edition, 1747.

periosteum must be raised." He further says, with regard to the dressing of these wounds:—"I think it is very certain that as the greatest part of the evil proceeds from the quantity and pressure of the matter, whatever approaches towards the nature of a tent and increases its quantity and pressure by locking it up, must be pernicious; therefore, I would exclude the use of all sindons whatever; the hasty application, too, of spirits of wine, which is so commonly advised, cannot be proper, as they are not only unfit for inflammations in general, but also crisp up the vessels of the dura-mater and brain, and, stopping the suppuration, sometimes produce a gangrene.

"Since, then, a close application is inconvenient, and whatever good there may be in topical medicines, it cannot, for the most part, be communicated to the abscess, by reason of its extent beyond the orifice, the best remedy will be dry lint only, which must be laid on loosely to give vent to the matter, and be repeated twice a day until the discharge is lessened, when once in twenty-four hours will be sufficient to the finishing of the cure, which will be sometimes retarded by the exfoliations that sometimes follow this operation."

I have quoted more fully from this author, because his treatment appears to be original—a stride greatly in advance of that which had held sway for 1600 years; the use of sindons with various ointments, oxymels, and the almost universal employment of the oil of roses. His procedure appears to be the dawn of that treatment, the influence of which has been felt down to the time of the introduction of antiseptic surgery.

The views of Sharp seen to have spread to the continent, as I find Platnerus[1] preferred the incision in the form of the letter X, directing the pericranium to be separated from the bone, for if it be lacerated by the terebra, it would produce fever with inflammation; he considered it very cruel immediately to cut off the angles of the incised scalp with a pair of scissors; it is better to leave them and place lint between them and the bone. Speaking of the cure, he says:—"If the membrane of the brain be laid bare, but

[1] Platnerus' "Institut. Chirurg.," Lipsiæ, 1758.

otherwise entire, the best application to it is a sindon of clean fine linen, which is to be placed within so that it pass under the edge of the skull; through this a soft thread is to be passed, the ends of which are to be tied together and to be left out of the wound, so that it may be conveniently taken away. Over the sindon dry lint is to be applied, especially if all the humour cannot be evacuated, for the lint may imbibe it."

Gooch[1] says that the incision of the scalp should be made with a knife, appropriated to this use, of a circular, elliptical or other figure, as the circumstances of the case require, and that "the scalping should be of such extent as may give a fair opportunity of making as many perforations as shall be found necessary, as far as the surgeon's judgment and observation can direct him. He ought not to be sparing in this respect, lest he should be under the disagreeable necessity of extending the incision further. The manner of cutting is to apply force enough to the knife to carry it quite through to the bone at once, not bearing too much upon the point, especially if he cut over loose fragments. The pericranium is to be raised a little with the point of the knife quite round the incision and then the scalprum used, which will be found the best instrument to clear the bone of that membrane, as I have found by frequent experience."

A little more than a century ago, operative interference was the rule in all fractures of the skull. It was Quesnay, himself, an advocate of the practice of interference, who gave force to the opinions of dissentients, by the very title of one of those masterpieces of clinical study, embodied in the memoirs of the old academy of surgery.[2] It fell to the lot of another of the academicians to substitute for traditional empiricism, rules and practice as prudent and safe in their application as their conception was enlightened and their demonstration closely and carefully reasoned; with few reservations, Desault was opposed to the use of the trephine in fractures of the skull.[3] It was otherwise on

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[1] Gooch's "Surgery," vol. i., 1767.

[2] "Precis de diverses Observations sur le trepan dans les cas douteux," Paris, 1774.

[3] "Œuvres Chirurgicales de F. F. Desault," Paris, 1801.

this side the channel with his great rival Percival Pott; the elevator and the trephine were his favourite instruments, as the following quotation shows:—"The number of cases of this kind which are necessarily brought into a large hospital so situated as St. Bartholomew's, in the midst of a populous city, where all kinds of hazardous labour are carried on, has enabled me to make many observations upon them; and although I have now and then seen some of them do well without the use of the trephine, yet the much greater number whom I have seen perish with collections of matter within the cranium, who have not been perforated, and for whom there is no other relief in art or nature, has, I must acknowledge, rendered me so very cautious and diffident that although I will not say that I would always and invariably perform the operation in every case of simple fracture, yet the case must be peculiarly circumstanced, the prospect much fairer than it most frequently is, and my prognosis delivered in the most guarded apprehensive manner, when I omit it."[1]

And, again, he expresses his strong opinion — "that enlarging the opening of a fracture, by means of a trephine, will not produce or occasion much risk or hazard, additional to what must be occasioned by the fracture itself that has already let in air upon the membrane; and, therefore, that *that* consideration is, at all events in some degree, at an end," and so he goes on to argue that, as a matter of *prevention*, operation ought to be had recourse to in nearly all simple or compound fractures of the skull. Moreover, he did not confine his operation to one perforation of the skull, but occasionally trephined in two or three places so as to embrace the whole of the fracture in the parts so removed; and yet I find, in spite of treatment so heroic, not a few successful cases recorded in his work on surgery.

So great was the ascendancy of Pott in the surgical world that his heroic action had many imitators, foremost amongst whom was his most illustrious pupil, John Hunter, who went so far as to advocate the trepan in all doubtful cases, as the operation "can do no harm."[2]

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[1] Pott's "Surgery," edited by Sir Jas. Earle, London, 1808.
[2] "The Works of John Hunter," London, 1837.

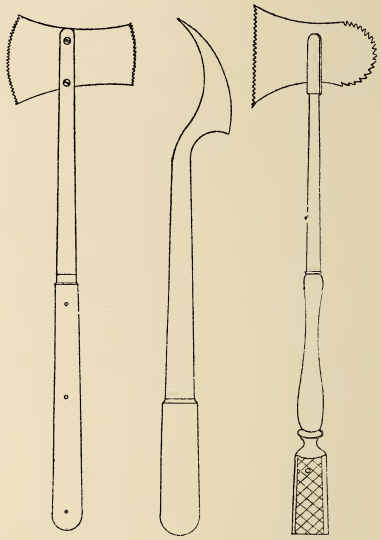
William Hey,[1] of Leeds, held that it was rarely necessary to remove any portion of the scalp whilst it remained in a sound state, and, therefore, recommended that, where the trephine is applied, a gentle separation of the divided parts will afford ample room for the application of the trephine. He held that the use of the trephine caused an unnecessary destruction of the cranium, because the piece of bone sawn out must be of one figure, whatever be the form of the

Pott's Elevator.

fracture, and the quantity of bone removed must be generally greater than the case required. He ably discusses the application of the instrument in various conditions, and says :—" When a broken fragment of bone is driven beneath the sound contiguous part of the cranium, it frequently happens that the extraction cannot be executed without removing some of the unbroken part under which the fragment is depressed. This might generally be effected

[1] " Practical Observations in Surgery," 1814.

with very little loss of sound bone if a narrow portion of that which lies over the broken fragment could be removed, but such a portion of bone cannot be removed by the trephine. This instrument can only saw out a circular piece, and as, in executing this, the central pin of the saw must be placed upon the uninjured bone, it is evident that a portion of the sound bone, greater than half the area of the trephine, must be removed at every operation. When



1. Skull saw. 2. Wheelhouse's elevator. 3. Hey's skull saw.

the broken and depressed fragment is large, a repeated application of the trephine is often necessary, and a great destruction of sound bone must be the consequence.

When the injury consists merely of a fissure with depression, a small enlargement of the fissure would enable the surgeon to introduce the point of the elevator so as to raise the depressed bone. But a small enlargement of the

fissure cannot be made with the trephine. When it is necessary to apply the elevator to different parts of the depressed bone a great deal of the sound cranium must be removed, where a very narrow aperture would have been sufficient.

The same reasoning will apply to the case of openings made for the purpose of giving a discharge to extravasated blood or matter.

If a saw could be contrived which might be worked with safety in a straight or gently curvilineal direction, it would be a great acquisition to the practical surgeon. Such a saw I can, with confidence, recommend, after a trial of thirty years, during which time I have rarely used the trephine in fractures of the skull.

It was first shown to me by Dr. Cockell, of Pontefract, to whom we are indebted for the discovery or revival of this instrument. A saw, formed on the same principle, is represented in Scultetus's "Armamentarium Chirurgicum."

Desault's conservatism told directly on his civil practice, not merely of his own countrymen,[1] but of British surgeons.

John Bell,[2] with his true surgical instinct, with his impetuous energy, and with the furbished eloquence of his ripe culture, threw in his lot against the trepan.

"After the expiration of my apprenticeship," Sir Astley Cooper says,[3]—"I went over to Paris to see the practice of Desault at the Hôtel de Dieu; I there found that scarcely under any circumstances did he trephine."

Abernethy[4] and Laurance[5] too, were disciples of Desault, as the following extracts show. Abernethy differed in his practice from the course insisted on by Pott. He observed that a slight pressure from depressed bone did not interfere with the proper discharge of brain function; and whilst admitting that the pressure so exercised might in some cases set up irritation at a future time, he thought that

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[1] Dupuytren, "Leçons Orales de Clinique Chirurgicale," Paris, 1839.

[2] "On Fracture of the Skull with Depression," in John Bell's "Principles of Surgery," vol. ii., London, 1806.

[3] Lectures by Sir Astley Cooper on "Surgery," vol. i., London, 1824.

[4] "The Surgical Works of John Abernethy," vol. ii., London, 1827.

[5] Quoted in Guthrie "On Injuries to the Head affecting the Brain," London, 1842.

generally the parts beneath became accustomed to it, and no evil results followed, and he thus cautiously expresses his view of the treatment to be pursued:—"From all I have learned from books, as well as from the observations I have made in practice and from reasoning upon the subject, I am disposed to join in opinion with those surgeons who are against trephining in *slight* depressions of the skull, or small extravasations on the dura-mater."

Laurance held, perhaps, a more decided opinion than Abernethy, he being certainly opposed to interference in cases of fractured skull, except where symptoms or other conditions clearly indicated it. Mr. Evans[1] says:—"I well remember some years ago, the late Sir Wm. Laurance saying in the wards of St. Bartholomew's Hospital, where a case had been recently trephined by one of his colleagues, that his experience of forty years in the wards of that hospital was, that such injuries did as well without operation as with it." On the same side must be mentioned one of the most enterprising surgeons of the century—a master who combined, in a very rare degree, fearlessness and judgment, power of brain and skill of hands. I allude to Robert Liston.[2] He thus writes:—"When fracture of the skull is complicated with wounds of the scalp the surgeon will not in general mend matters much by trephining, as has been advised merely because there is a wound; if the depression is pretty extensive and unless he has a bette reason to give for the proceeding than the mere circumstance of the fracture being compound, he will often thus add as much to the injury, and to risk which the patient is subjected to by it, as he would by dividing the scalp in simple fractures."

This warning is of special significance, emanating, as it does, from one who had had abundant opportunity of witnessing the effects of the trephine and elevator, and who possessed operative skill and courage in so high a degree, that he never felt the temptation to inaction as a refuge from responsibility.

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[1] *St. Bartholomew's Hospital Reports*, vol. iii.
[2] "Liston's Practical Surgery," London, 1846.

At a later stage of the history, Samuel Cooper[1] was equally conservative, but it is due to them to state that three of his contemporaries, Guthrie,[2] Brodie,[3] and Vulpian,[4] in the very first rank of surgical authorities, rather inclined to the heroic practice of Pott, than to the physiological watchfulness and gentle medical measures of Desault.

Coming to our own day, Bryant[5] says: "The result of modern experience and judgment has so far altered the practice of our predecessors as to render us cautious of inflicting an additional injury on our patient; but, at the same time, recommends trephining in all cases of punctured fracture, and where pus can be made out to exist between the bone and the dura-mater after a head injury, and also in local injuries, whether simple or compound, when incipient symptoms of brain irritation or inflammation appear two or three days after the injury, for there is a possibility that the symptoms originate in the presence of a fragment of bone irritating the brain or its membranes, which, if left, will go on to set up encephalitis." He holds that in diffused injuries to the skull the probabilities are all against the operation; in local injuries they are in its favour.

Holmes[6] considers trephining is indicated: (*a*) In cases of compression produced by depressed fracture or lodged foreign bodies; (*b*) in certain cases of irritation or symptoms of pressure supervening in depressed fracture; (*c*) in cases of localised pressure from extravasated blood; (*d*) in cases of intracranial suppuration where the symptoms are those of localised pressure.

Holmes is in favour of elevation in depressed fracture, if symptoms demand it, but, in the absence of symptoms, considers depressions best left alone; the more the fracture approaches the punctured form, the more is the trephine indicated.

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[1] In "Dictionary of Practical Surgery," London, 1838.

[2] "On Injuries of the Head affecting the Brain," London, 1842.

[3] "Pathological and Surgical Observations relating to Injuries of the Brain," by B. C. Brodie, F.R.S., in *Medico-Chirurgical Transactions*, vol. xiv.

[4] Vulpian, "De l'Operation du Trepan dans les Plaises de Tete," Paris, 1834.

[5] Bryant, "The practice of Surgery," London, 1876.

[6] Holmes, "Surgery—its principles and practice," London, 1878.

Mr. Prescott Hewett strongly advocates immediate interference. He says, "In compound depressed fracture of the skull the rule is to operate, and at once."

Mr. Erichsen spoke even more emphatically. In his very admirable book on "Surgery," he makes the following remarks on the subject: "So far as my own experience is concerned, which is necessarily drawn purely from civil practice, I can say that I do not recollect ever having seen a case recover in which a compound depressed fracture of the skull, occurring in an adult, had been left without operation, but I have, on the other hand, seen several instances of recovery in which the bone had been elevated and fragments removed. The sooner this is done the better; danger does not arise from early operation, but from delay. The presence of depressed and spiculated fragments pressing into the dura-mater must infallibly and speedily induce encephalitis. I have several times trephined under such circumstances as these with success, and have never had occasion to regret doing so. Indeed, there is no class of cases in which the operation of trephining is attended by such successful results as in those of depressed and comminuted fracture."

Samson Gamgee[1] reported five cases of depressed fracture; in each case the scalp was divided, the bones of the skull broken and driven in, without, however, producing evidence of injury to the nervous centres. In none of the cases was the trephine employed, in all the result was perfectly successful. His conviction is that in all compound fractures of the skull, without *brain symptoms* the proper course of practice is not to trephine. He does not deny that there may be cases of compound fracture (depressed) justifying operative interference, as he has had occasion to operate successfully in such cases.

Mr. Wheelhouse,[2] in answer to the implied question whether we are any nearer now than we were in former times to a safe and sure rule of action in the treatment of depressed fractures of the skull: "No one will doubt, I think, that we see the trephine much less used now than

[1] "Clinical Lectures," Queen's Hospital, Birmingham, 1876.

[2] In his address on "Surgery," British Medical Association, Bath, 1878.

was the custom formerly, and in asking myself the question —Is this because it was used with unnecessary frequency *then*, or because we too seldom resort to it *now ?* the answer of the practical experience of my life comes without hesitation to my mind. As was the case with the lancet, so it was also with the trephine; its indiscriminate use in all, or nearly all cases of depression of the skull, whether simple or compound, was an undeniable evil, which has led to a revulsion of feeling in the minds of thoughtful men, and steadily as time has gone on and experience has accumulated, operative interference has been found to be much less frequently called for than was considered necessary in former days. Yet, in spite of all the aid derived from the various novel methods, antiseptic and otherwise, with which we dress our wounds, I cannot bring my mind to doubt the value of the old rule, that "in cases of compound depressed fracture, symptoms or no symptoms, where we can be at all clear that the entire thickness of the cranium is involved, it is the duty of the surgeon, either with the trephine or by some other means, to raise the depressed fragments or portion of bone, and so free the subjacent structures from irritation and pressure."

May I here digress to draw attention to the instrument depicted on page 42, known as Wheelhouse's elevator. To Yorkshire surgeons it is almost as well known as the eminent surgeon whose name it bears. The instrument is made of steel, six and three-quarter inches long, and fitted with a handle of turned wood which bring up its extreme length to nine inches; it is thus a powerful lever, and is most useful "as some other means" than the trephine to raise depressed fragments of bone. In other surgical work than on the skull—as removal of the sequestra in necrosis of long bones—it will often be found of more use than the ordinary elevator.

With regard to the foreign opinions of trephining, I add an abstract of a valuable paper by M. Schwartz in "Revue des Sciences Médicales," 1879. "Percival Pott, J. L. Petit, Quesnay Mehie, and De la Touche, frequently practised preventive trephining. The object of this operation was to prevent compression and inflammation of the brain, by opening the skull immediately after the accident. In the

language of modern surgery, however, trephining is said to be primary when it is performed in the course of the first few days following the accident, and either before the period of inflammatory reaction, or even after it has set in. It is necessary to bear this point in mind.

During the latter half of the present century, the operation has become almost obsolete. It was not until 1867, when Professor Broca published the results of his researches on the centres of localization of speech, that the attention of French surgeons was again directed to it. An animated discussion took place at a meeting of the Société de Chirurgie, when it was dicovered that trephining had been so rarely practised of late, that it was very difficult to collect a sufficient number of cases to justify or oppose the operation.

The year after this discussion, in which most of the celebrated French surgeons joined, M. Larrey presented to the Society, a paper on trephining, and the indications and contra-indications for performing the operation.

According to his experience, the operation was indicated:

(1) In cases of fracture of the cranium, when the fragments of bone press on the brain, and give rise to serious symptoms, which persist even after the fragments have been removed.

(2) In cases of fracture where the splinters and fragments of bones, or of foreign bodies, have penetrated into the substance of the brain, and it is impossible to remove them without trephining.

(3) In other complicated lesions of the skull, where there are symptoms of an accumulation of blood or pus pressing on the brain, and the usual therapeutic agents remain ineffective.

The following were the contra-indications for trephining:

(1) When a foreign body has penetrated so deeply into the brain that it cannot be recovered.

(2) If the blood or pus, contained in the skull, does not appear to form a focus in connection with the openings in the bone.

(3) In all fractures which are not complicated by any phenomena of compression or of paralysis, &c.

(4) In cases of cerebral commotion or coma.

(5) In epileptiform transitory convulsions.
(6) In cases of encephalitis or encephalo-meningitis.

The only drawback to this elaborate classification is that it is almost impossible to distinguish between these different lesions at the bedside of the patient. This difficulty, in fact, was one of the principal strongholds of the adversaries of trephining. The surgeons of the day were divided into two parties, but the prevailing opinion was against the operation.

In 1874, Sèdillot strongly advocated trephining in cases of fracture of the inner table of the skull; but as it was

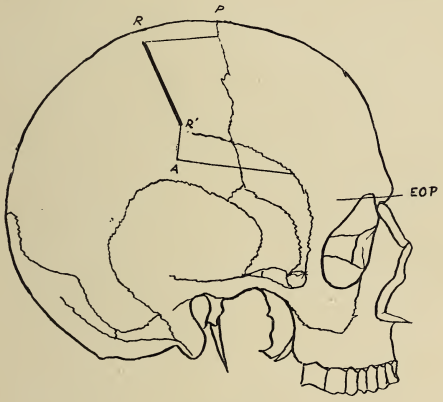


PLATE 16.

Guides for finding the line of the Fissure of Rolando.—(*Lucas Championniere.*)

very difficult to diagnose isolated fracture of the inner table, little attention was given to his doctrine till 1876, when M. Sèdillot presented to the Académie des Sciences a treatise on trephining, containing the results of 106 observations made by him. In this he proves that the chances of recovery decrease in proportion as the operation is postponed.

About the same time attention was attracted by the remarkable works of Hitzig and Ferrier on cerebral localization. They proved, by their investigations, that there

exist certain zones on the surface of the brain, in the fronto-parietal region, which, if irritated, will give rise to convulsions or contractions in the opposite half of the body. If these zones are removed or destroyed, paralysis of certain members follows. According to M. Vulpian, these zones act through the intermediary agency of the grey cortical matter, or through the white matter which is situated beneath the grey substance. Rochefontaine and Duret have shown that a certain proportion of the phenomena of irritation, such as convulsions and contractions, can be traced back to lesions of the nerves of the meninges, especially of the dura-mater. These phenomena ought, in fact, to be regarded as true reflex actions, of which we know the centripetal tract, the centre, and the centrifugal tract. Having once settled the different centres of localisation in the brain, the next step was to discover what particular places in the skull would correspond to the said centres. This could best be done by ascertaining the position of the fissure of Rolando, seeing that such of the motor centres, whose position is sufficiently well known, are situated around it. In the adult the mean distance from the bregma to the upper end of the fissure of Rolando is forty-seven millimetres. The number varies according to the conformation of the skull, but the deviations are very slight indeed. The bregma may be determined by the aid of Professor Broca's ingenious instrument, or by M. Lucas-Championnière's bi-auricular cartoons. The point where the bi-auricular line is intersected by the median line of the calvarium corresponds to the spot we wish to find.

In order to ascertain the inferior end of the fissure or sulcus of Rolando, draw a horizontal line for about seven centimetres from the external or bi-auricular apophysis. If a perpendicular be then erected on the posterior end of this line, and continued upwards for five centimetres, the inferior portion of the fissure of Rolando will be found to correspond exactly to this point. The localisation of the centre of speech is determined in the following way. A horizontal line is traced from the external or bi-auricular apophysis, and continued towards the crest of the frontal bone for about five centimetres. A perpendicular line, three centimetres in length, is erected in this spot. If the trephine

be applied to the region which is situated anterior to the fissure of Rolando, after it has been traced out in the way we have just described, it will affect the anterior motor centres. If the trephine be applied to the region situated behind the fissure of Rolando, it will affect the posterior centres.

It is natural that in proportion as a more thorough knowledge was obtained of the functions of the cortical substance of the brain, and especially that portion of it which is closely connected with the skull, professional

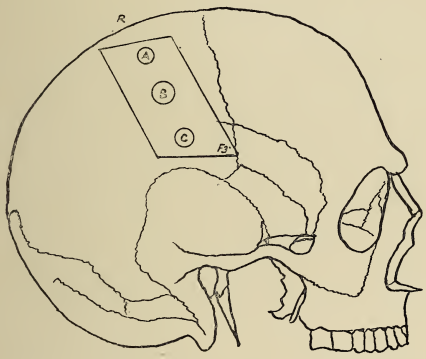


PLATE 17.

Situations in which the trephine may be applied:—
A for the centre of the lower limb.
B for the upper limb.
C for the centre of the face.
F_3 situation of Broca's convolution.

opinion became gradually more reconciled to the operation. This new phase was ushered in by the works of MM. Proust, Terrillon, Lucas-Championnière, Pozzi, Gosselin, and Le Dentu. The two latter presented each a report on the subject, the former to the Académie de Médicin, the latter to the Société de Chirurgie, which contain a fund of valuable information for the surgeon.

"In France, according to the opinion of such eminent surgeons as Dr. Legouest and Dr. Tillaux, the removal of

splinters or fragments of bone from a fracture of the skull, does not constitute primary or preventive trephining. It is merely a surgical operation, such as would be resorted to in any case of fracture, and performed with the aid of appropriate instruments.

"Concerning primary trephining (for the preventive trephining has become nearly obsolete in spite of Sèdillot's endeavours to restore it) modern surgeons are divided into three parties. Those who look upon the doctrine of cerebral localisation as not being sufficiently established yet, and who do not feel themselves justified in diagnosing a cerebral lesion from a functional symptom, have remained, as it were, stationary. M. Gosselin and the German Surgical School represent this opinion. The theories of this party may shortly be summed up as follows: Preventive trephining can be resorted to without any danger, and even be useful in cases where the skull has already been opened by a fracture; but it is more dangerous than useful, whatever the functional symptoms may be, when the skull has not been fractured, and would have to be opened by the operation. To the second category belong the surgeons who believe to a certain point in the doctrine of localisation. They admit that the operation may prove useful under the following circumstances:—

"(1) In cases where it is necessary to remove foreign bodies or fragments of bone from the dura-mater and the brain.

"(2) When it is necessary to promote the evacuation of accumulations of blood or serum between the dura-mater and the brain, as these are liable to exert a deleterious influence on the brain, either through putrefaction or by pressure.

"(3) For the purpose of allowing purulent accumulations to escape.

"Trephining is always dangerous when it establishes a communication between the arachnoidal cavity and the air. It follows that in cases of existing fracture it may be performed without danger. Messieurs Le Dentu and Legouest object to preventive trephining. Primary trephining may be resorted to in cases of convulsions which

are caused by a limited depression of the skull, or by general hemiplegia, accompanied by stertorous breathing and loss of consciousness. In all other cases it is best to wait, as it often happens that all these symptoms disappear without surgical treatment. If, however, the serious symptoms persist, or become more intensified, the operation must be resorted to at once, but no more crowns should be applied than are necessary. In short, the practitioners ought entirely to be guided by local symptoms, and not by the situation of the centre, the peculiar condition of which gives rise to certain symptoms.

"The third class is represented by M. Lucas-Championnière. He teaches that trephining may be determined solely by the cerebral localisations, and that even preventive trephining is admissible. The operation is indicated in cases where it is necessary to raise up or remove fragments of bone which irritate the brain, to remove a foreign body, or to evacuate an accumulation of blood in the brain. It may also be performed at a later period for the purpose of removing splinters, raising a depression or evacuating a purulent extra- or intra-cerebral gathering. If, however, no apparent lesions or accidents take place after a trauma of the skull, it is advisable to wait. If the patient presents depression of the skull without any brain-symptoms, the surgeon must hold himself in readiness to trephine at a moment's notice. The same precautions must be taken in a case of traumatic fracture without depression.

"If the patient be comatose, the operation must be resorted to in cases of depression of the skull, or of paralysis or convulsions of the opposite half of the body. M. Lucas-Championnière is so much in favour of trephining, that he regards it as indicated in cases of paralysis where any other symptoms are absent. In secondary paralysis, the indications are less formal. In general hemiplegia, the operation may be safely performed, as the lesion is probably an extensive one. In cases of convulsions, with or without paralysis, the operation is *de rigueur* if the convulsions be localised.

"As far as fractures of the inner table are concerned, trephining must be performed whenever the symptoms appear serious. The trephine must be applied to that

particular spot of the surface of the skull which corresponds to the affected centre. The latter can easily be identified by symptoms of paralysis or localised convulsions. It does not do to be too timid; and a number of trephines can be safely applied. In short, the author has come back to the doctrine of 'preventive trephining.'

"In Germany, the majority of surgeons were even more opposed to the operation than in France. Beck, Bergmann, Chelius and Roser admit it only in exceptional cases. Nussbaum, Esmarch and especially Stromeyer are very much against it. It seem, however, as if, of late, a gradual reaction in favour of trephining were taking place in Germany, as is evident from Bluhm's treatise on the subject. In fact, Fischer, Roser and Bergmann recommend trephining with a view to prevent encephalo-meningitis, and in certain cases of depression of the skull which may be recognised easily by the existence of a wound or a visible depression of the bones of the skull."

Agnew, of Philadelphia, in his work on "Surgery," considerers the following conditions demand trephining:

(1) When there is a depressed fracture of the skull with *persistence* of compression.

(2) A compound fracture of the skull, accompanied by symptoms of compression, with or without depressed bone.

(3) In compound fractures with depression, even though no symptoms of compression be present, it will be proper to elevate the depressed portions of bone.

(4) In compound comminuted fracture with depression, whether symptoms of compression exist or not.

(5) In punctured fractures, with or without signs of compression.

(6) In cases of traumatic epilepsy where the traces of the injury originating the disease can be recognised upon the cranium, where there are frequently-recurring convulsions which are not in any way controlled by internal remedies, and where the mental powers are becoming greatly impaired, rendering the patient unable to transact the common business affairs of life, or incapable of using the ordinary precautions for self-protection, the use of the trephine is entirely justifiable, and offers the unfortunate sufferer the only prospect of relief.

(7) When, from three to five days after a compound fracture, symptoms of meningitis or encephalitis develop, and when there is reason to believe that these have been produced by a scale or spicule of bone from the inner table pressing against the brain the use of the trephine will be indicated with which to remove the osseous splinter, or, in case such spicule should not be present, to give exit to the inflammatory products which, sooner or latter, must destroy life unless removed.

(8) In cases of brain compression, whether from traumatic or other causes, in which there are strong reasons for believing that the symptoms are the result of blood or pus, and where the surgeon is able to locate the offending cause with a reasonable degree of certainty.

Trephining in Syphilitic Diseases of the Bones of the Skull.

Mr. Henry Lee, Surgeon to King's College (in *Proceed. Royal Med. & Chir. Society*) gives the particulars of two cases in which the bones of the skull were very extensively diseased. In the first, the outer and middle table of the frontal bone, principally on the left side, and part of the left parietal bone, had become necrosed, but the internal table retained its vitality when the trephine was applied. The inner surface of the portion of bone which was removed presented a very uneven surface, from whence numerous small, irregular spicula of bone projected. The dura-mater, which had been in contact with these, was altered in structure and did not bleed, as the dura-mater usually does when a portion of bone is removed by the trephine.

There was here general debility, loss of sensation on the right side of the face, and deafness in both ears. There had been also extensive and long-continued ulceration on the left side of the neck. The removal of the portion of bone was followed by general restoration to health, recovery of the sensation of the face (with the exception of a small portion of the right side of the upper lip, which still remains numb) and perfect hearing.

In the second case there was extensive disease of the outer and middle tables of the skull. The patient became,

in consequence, subject to a peculiar kind of fit. This commenced with flushing of the face, followed by twitching of the muscles of that part. The fit would then sometimes terminate; at others, however, it would be followed by rigidity of the muscles of mastication and of the other muscles of the body. Some of these fits lasted as long as six hours, during which the patient retained his consciousness. This patient was affected with an ulceration which lasted over a period of between eight and nine years, and which had extended over the skin of the whole right arm, from the shoulder to the wrist.

The application of the trephine, in this case, was made over the right temporal bone; the portion of the internal table removed was slightly roughened, but not nearly so much as in the preceding case. The fits recurred a few hours after the application of the trephine, but ultimately ceased. The ulceration of the right arm, which had existed between eight and nine years, healed, and the patient was restored to a comparative state of health.

The object of the trephining in these cases, was:

(1) To remove the cause of irritation from the surface of the dura-mater.

(2) To allow the discharge of any matter there secreted.

(3) To establish a healthy suppuration from one part of that membrane, whereby the irritation, caused by the prolonged contact of diseased bone, would be relieved.

The author directs particular attention to the prolonged, persistent, and recurring ulcerations of the skin, which formed one of the most troublesome symptoms in both cases.

In illustration of the cause of these ulcerations, he refers to M. Brown-Sequard's experiments, in which it was shown that by cutting off the sympathetic nervous influence from a part, the vessels of that part become dilated, and also to M. Majendie's experiments upon the fifth nerve, by which it was shown that ulceration might follow the abstraction of nervous influence.

Brown-Sequard has also shown that by irritating certain portions of the nervous system an animal might be rendered liable to epileptic fits. In case 2, the author attributes the occurrence of the fits to the irritation produced in the membranes of the brain by the continued contact of the

diseased bone, and concludes that the removal of even a comparatively small portion of that bone, so diseased, was calculated to relieve the irritation, as it certainly appeared to have done in the cases recorded.

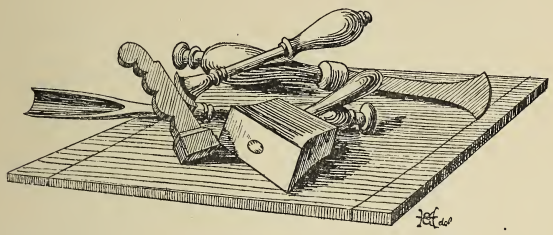


PLATE 18.

Mallet and scalper cavus.—*Bell's Surgery.*

Appended are short reports of cases which have come under the author's notice—either under his immediate care or that of his colleagues, in which there seemed no doubt of the necessity of the operation to save life, and the result, in each case was most satisfactory.

SUCCESSFUL CASES OF TREPHINING.

CASE I.

Depressed Fracture of the Skull, Trephining, Small Fungus Cerebri. Recovery.

The author's case. Private practice.

W. A., age 9, February 17, 1882, was standing, about 9 a.m., outside his father's shop, teasing a horse attached to a cart, when the horse turned upon him, seized him by his trousers behind and tossed him in the air; he fell with his head on the curbstone; was taken up bleeding and carried into the house.

I saw him at 10.30 a.m. There was a wound in the scalp over the right frontal eminence and extending through the superciliary ridge in a transverse direction towards the

nasal eminence, the finger introduced into this, came down upon a depressed punctured fracture, which bled slightly; the patient was semi-conscious, answering questions when spoken to loudly, and speaking petulantly. The pupils were equal, of normal size and acted readily to light; pulse regular, small, 90.

At 11 a.m., my assistant (Mr. Hall) gave chloroform. I then lengthened the wound in the scalp at both ends. The depression was formed by the driving in of the outer table to the extent of two inches in length, and varying from one to half-an-inch in breadth. A small trephine was now applied; and then, by means of Wheelhouse's elevator, the outer table was easily removed. The fracture of the inner table was much greater in extent and comminuted.

Here I must state, in prizing up one of the fragments with a small elevator, it, much to my annoyance, slipped off the fragment and penetrated the membranes of the brain. The bleeding became profuse; the loose pieces of the inner table of the skull were removed, and sharp corners of the bone cleared away by Hey's saw.

I was unable to get at the cause of the bleeding, which was evidently venous, the blood welling up in the wound each time I removed the sponge, the brain pulsating through the wound in the membranes. The scalp was laid over the wound—no sutures were put in—and covered with lint soaked in carbolic oil, a large pad of lint over this, and pressure applied by means of a bandage, and the patient removed to bed.

3 p.m.—The bandage soaked with blood; the patient conscious, lying quietly in bed; pupils normal; does not complain of the pressure of the bandage. 10 p.m.—Bandage relaxed; temperature 100°; pulse 96.

18*th*.—Has slept; woke up several times and cried to his father that the horse was upon him; complains of headache; answers questions rationally; temperature 99.2°; tongue a little furred at the edges; bowels open; pupils and respiration normal; bandage and pad removed; dressing allowed to remain undisturbed; ordered a milk diet. Evening, temperature 100.5°.

19*th*.—Morning, temperature 99°; had a restless night; necessary to hold him in bed, delirious, but calmer towards

morning; pupils normal; skin moist; lint removed and wound sponged and syringed with weak carbolic lotion, and also re-applied on lint; complains of no pain. Evening, temperature 100°.

20*th*.—Again passed a restless night, tossing about a good deal; morning, temperature 98.5°; wound looking healthy and discharging freely; the brain pulsating through the wound; ordered a chloral and bromide draught for night, if needful.

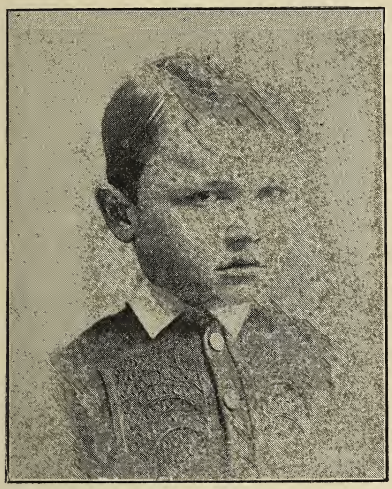


PLATE 19.

21*st*.—With the draught has had a good night; temperature normal. On my morning visit the patient was turning over the leaves of a picture book.

24*th*.—Pus discharging freely from the wound, and also from the right ear; membranes pulsate on a level with the wound; temperature normal; eating well.

30*th*. — Wound filling up with granulations; hernia cerebri has become as large as a marble; pus still discharging freely; to be syringed with the carbolic lotion.

March 7*th*.—Wound filling up level; pus has ceased to

be discharged from right ear; wound discharging pus freely.

14*th.*—Gets up daily; the wound looks healthy and filling up around the fungus cerebri; pressure, by strapping, applied to bring the edges of the wound together.

The sequel of the case, shortly:—As the wound healed and cicatrisation followed, the hernia became snickled at its base by the new tissue, and by a few applications of nitrate of silver, it withered and disappeared. The case, in fact, recovered without a bad symptom.

The cicatrix measured three inches long; the brain can yet be seen pulsating in it. The mind is not the slightest impaired. No paralysis ever showed itself, and now, after an interval of six months, the boy remains perfectly well.

The plate shows the appearance of the wound, completely healed, six months after the receipt of the injury.

Ten years afterwards the patient was acting as carman, perfectly well.

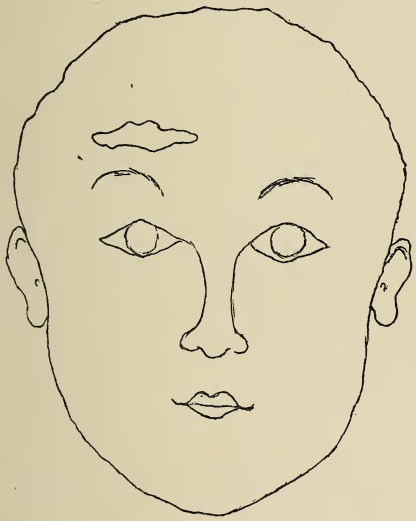
Case II.

Compound Fracture of the Skull with Depression—Trephining Hernia Cerebri. Recovery.

Author's case—Leeds General Infirmary, during his House Surgeoncy under the care of Mr. C. G. Wheelhouse.

W. G., aged 8. August 24th, 1875. A quarter of an hour before admission he was knocked down in the street by a passing spring cart. On admission at 8.30 p.m., there was a large gaping wound on right temple bleeding. On examination a depressed fracture of the eminence of the right frontal bone was found extending transversely across the bone to within an inch of the median line, with depression of both the inner and outer table. There was no concussion, the compression producing no symptoms. The pupils were equal, and contracted normally to light. He was perfectly conscious, and cried a little during the shaving of the scalp and cleaning of the wound. The wound was enlarged and the scalp turned back and then presented a deeply depressed gutter-shaped fracture with the edge of the depressed portion wedged under the sound portion

of the skull, fixed and immovable. The patient was placed under chloroform, and Mr. Wheelhouse trephined off the edge of the depressed portion, and then by means of bone forceps and elevator removed the spicula of bone. Several of the fragments were driven into the brain substance; profuse hæmorrhage followed their removal. Pressure by sponge and bandage was sufficient to control the bleeding; the edges of the wound were brought together without sutures, and a pad of lint and cold water applied.



Site of wound on admission.

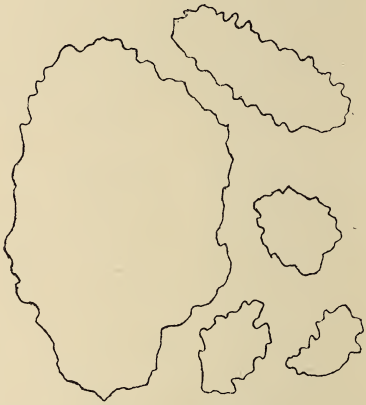
25*th.*—The patient passed a good night, moaning occasionally; bowels not moved; calomel gr. ii. with pulv. jalap. gr. x. administered; right eye closed from œdema of lids; no further hæmorrhage; pupils equal; tongue coated; temperature 99°; pulse 78; respirations 16.

26*th.*—Slept well; wound looks healthy, a slight sanious discharge; cerebral pulsations distinctly visible, also a

small quantity of brain tissue at base of wound; bowels open twice; tongue slightly furred; pulse 78; temperature, morning 99°; evening 100°; respirations 18.

27*th.*—Good night; eyelids less puffy, but going black; is perfectly conscious and takes his food well; temperature, morning 99°; evening 99.6°; pulse 90; respirations 18; bowels open.

28*th.*—Passed a fair night, had some headache; rep. pulv.; pulse 110; temperature 99°; evening temperature 100; respirations 16. There is a slight prominence at the lower part of wound which pulsates.



Fragments of bone removed—natural size.

30*th.*—Bowels open; slept well; the swelling at base of wound gets larger and the pulsation increases.

October 5*th.*—Pulse 90; respirations 20; temperature, morning, 98.6; there is a hernia cerebri about the size of a large bean, which increases; it is surrounded by healthy granulations. The wound is still dressed with carbolic lotion.

24*th.*—Granulations filling up the wound with formation of healthy pus.

September 13*th.*—Brain granulating, pulsating, protruding; the hernia is now the size of a marble.

26*th.*—A little pressure made by bandage; the granulations are surrounding the base; there is hope that this may be the means of cure.

October 4*th.*—Pressure on the hernia cerebri made by a bag of small shot.

10*th.*—Hernia much reduced; nitrate of silver applied to the prominent granulations.

November 6*th.*—Discharged; the wound perfectly healed; some pulsation remains, which is increased by emotion, and there is some thickening below the cicatrix.

Some time after this date I saw the patient. He was quite well; wound soundly healed; mind perfect, and he had returned to school work.

Case III.

Under the care of my colleague, Mr. Jeffery, whom I assisted with the operation.

T. N., 38, wire drawer; admitted July 19, 1889, to hospital, with the following history:—On May 13th, received blow on head with a sharp-pointed piece of iron, which only partially stunned him; immediately walked three miles home; queer in his head ever since; a week afterwards complained of weakness in left arm and slightly in leg; variable pupils noticed, and always had headache; got worse; constantly restless; never walked since week after accident; much vomiting; sometimes blood (?); no discharge from ears, but complained of pain.

Condition on admission.—Small sinus in scalp leading to bare bone, about the middle of the posterior edge of right parietal bone; sometimes speaks sensibly, at other times not; sometimes answers question fairly quickly, at other times has amnesia—no aphasia; slight facial paralysis of left side, with conjugate deviation to right; right pupil generally widely dilated, sometimes contracts; partial paralysis of left arm, keeps it flexed rigidly and slight tremors, no reflexes, straightening it forcibly causes pain; left leg, power very slightly impaired; ankle clonus; very restless; passes urine naturally.

July 20*th.*—Under chloroform, trephined, punctured fracture; bit of bone size of figure, sticking into brain; small quantity of pus under dura-mater syringed with lig. hyd. perch.

The after history of the case, shortly:—Passed a poor night, with delirium; some slight suppuration occurred; for a few days he was restless; by the 29th he was quiet; talked well; pupils were equal; facial paralysis had almost disappeared; there was more power in left arm, and, in another week, was comparatively well.

Case IV.

M. D., 55, miner; admitted October 23rd, 1889; under my colleague, Mr. Blackburn with the following history:

Run into and knocked down by a passenger train running at considerable speed. No clear account, nor actual witness. Picked up stunned and brought into hospital.

Condition.—Two scalp wounds on right side—one over parietal suture a little to right of middle line—the other a little more to the right side and about the middle of the parietal bone, a depressed fracture is easily felt with the finger; there is also a bruise on the left side of his back, and on the right side one or more ribs are broken.

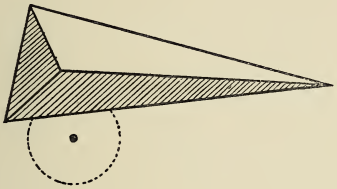
He is semi-conscious; sometimes speaks distinctly; no sickness nor paralysis; breathing quickly; pulse 80; pupils natural; passes urine under him.

Operation.—Wound enlarged, fracture found, this shape and size, dotted line shows trephine mark (see figure), bone was found pressing on brain and removed; there was very little hæmorrhage. Wound sewn up with drainage tube in.

Evening.—Patient keeps quiet, has passed some blood-

stained urine; catheter discovers nothing; pulse and temperature normal.

October 25*th*.—Still in same condition; talks distinctly and sometimes rationally; nothing through dressing; pulse and temperature normal; breathing rather gurgly, and breathing sounds in region of fractured ribs with abundant râles; has not spat any blood.



October 27*th*.—More sensible this morning; pulse and temperature normal; takes milk well, and sleeps well. B.N.O. glycerine suppository; no paralysis; hæmaturia gone; respirations gurgly; no hæmoptysis.

November 20*th*.—Since operation has been gradually improving; at first very restless and delirious; slowly quieted down; and has become more and more sensible, though not quite so yet; temperature and pulse have kept steady all along.

February 15*th*, 1890.—Discharged. Wound practically healed.

Up to this date one point will be noticed, and that is, while lesions of the head have, in the annals of surgery, held a foremost place, the effort of the surgeon was directed to the skull and its membranes; and was exclusively confined to the result of the injury. As Macewen[1] tells us: "Their operations were simple, undertaken for the most part upon the primitive evidence of direct visual and tactile observation. There is no reference made by them to cere-

[1] Address on "Surgery of the Brain and Spinal Cord," 1888.

bral surgery, as it is now known. The brain, whose function at that time was little understood, inspired fear; it was ultimately associated with the seat of life; it was the mysterious dome of thought. It gave lodgment in its recesses to the soul, and was surrounded by all the mysticism which a highly speculative philosophy inculcated. Although surgeons did not share the popular belief that to touch the brain was to induce certain death, yet they had just grounds for concluding that, to them, it was practically inviolable.

"*Post-mortem* examinations revealed the fact that many cerebral lesions could have been easily reached, had the surgeon only known, during life, at what particular part they had been situated. There were two formidable barriers to the advance of surgery in this region:—First, the fact that the majority of intra-cranial operations were attended by inflammatory action, which so often proved fatal as to cause surgeons to shun active interference; and, secondly, the brain was a dark continent in which they could descry neither path nor guide capable of leading them to a particular diseased area, and, did they attempt to reach it, it could only be by groping in the dark. Therefore, they were constrained to confine their efforts to traumatic lesions, and of these to such as afforded external indications of their presence, and what called out clamantly for relief. From the days of Pott to our own, there seemed to be a growing conviction not only of the impotence, but of the positive harmfulness of active interference; so that the trephine was regarded as an almost obsolete instrument. Yet surgery was fully abreast of the physiology of the day."

Macewen further proved that two factors were necessary for the introduction of cerebral surgery and demonstrated how they were to be obtained; he says: "However wishful one might be to extend the sphere of surgery to the brain, it was necessary first to adopt means whereby immunity from the inflammation, which so constantly attended brain lesions, could be secured, and secondly to endeavour to gain a better physiological knowledge in the hope that light might be shed upon the localization of cerebral lesions."

In the wards of Glasgow Royal Infirmary, Lister had formulated the theory, and wrought out the practice of the antiseptic treatment of wounds, and already much had been done to dissipate the fears of surgeons regarding operations practiced on other parts of the body. Experience, gained by me, showed that not only compound fractures of the skull, but large osseous defects in the cranial vault accompanied by extensive loss of cerebral substance, were quite amenable to treatment, exhibiting no tendency to inflammatory action, so long as the tissues were preserved aseptic. When this held true of the rough and often septic lesions produced by machinery accidents, how much surer would well-planned and carefully executed operations be? This conclusion was subsequently amply confirmed by the results of operations undertaken by me for the relief of injury, in which the brain had to be exposed and from which detached portions of it had to be removed. In such instances no inflammatory phenomena interrupted the even course of the healing. A striking feature of these wounds of, and operations upon, the brain, was the absence of false hernia cerebri, which had hitherto formed such a conspicuous complication of brain lesions in man, and which had so often marred the success of physiological experiments by extending the zone of irritation, and by the fatal results which ensued. It was thus manifested that inflammation arising from exposure of, and operations upon, the cerebrum, could be obviated under aseptic precautions.

Meanwhile many workers had been sedulously endeavouring to unravel the intricate and complex questions relating to the structure and functions of the brain. Previously the cerebrum was supposed to perform its function, as a whole, in the same way as the liver, heart and kidneys performed theirs, there being no differentiation of function. Broca, in 1861, from observation on human pathology, isolated a particular limited area as the seat of the faculty of articulate language. This very important investigation foreshadowed the localization of functions in other cortical centres; for, if the existence of a definite function confined to an isolated area were admitted, then the question arose, how many other centres with specialised functions might there be? Broca's discovery was thoroughly iconoclastic;

it shook the notion entertained regarding the unity of brain function to its foundation; it awakened thought and made men explore anew, with critical eyes, fields which previous investigators were supposed to have exhausted.

Dr. Alexander Robertson, of Glasgow, suggested, in 1866, that there were separate sets of fibres for the conveyance of special motor impulses from the cortex. Hughlings Jackson, in 1869, stated that there were many limited areas on the brain connected with separate and distinctive functions, founding his opinion, not on speculative deductions, but on clinical experience and on the direct observation of pathological facts. The inception of the idea that there was a portion of the brain whose function was related to motion was treated with extreme scepticism, and the suggestion was likely to have long remained a speculative question had it not been for the advent of another and more direct mode of examination. This new departure consisted in the performance of experiments upon the lower animals, by Fritsch and Hitzig, who, in 1870, published an account of their observations. They demonstrated the existence of a series of circumscribed areas on the surface of certain of the cerebral convolutions, the electrical stimulation of which caused on the opposite side of the body co-ordinated movement in distinct groups of muscles. These were momentous facts destined to revolutionise former ideas of cerebral function, but their full force and significance were not recognised, in this country at least, until Ferrier's observations on the brains of animals, undertaken to put to an experimental proof the views entertained by Hughlings Jackson, were published in 1873. Then the mind of the physiological world was fairly awakened. The suggestions of Hughlings Jackson, on the motor cortex became crystallised. Another link in the unity of plan of creation was manifest, as even in the higher and more complex brain of man parts existed whose function found homologous expression in that of the lower animals. Abundant proof has been gathered from human pathology, such as that afforded by the elaborate observations of Charcot and Pitres, to put beyond cavil the broad fact that there are points in the human cortex cerebri intimately related to the motor and sensory functions of certain parts of the body.

It is a matter of history that Dr. Macewan's address took the profession by storm, and it was well said that in many respects it was the most remarkable contribution to surgical literature which the present day has produced. "When we recollect how rare were the occasions on which, a few years since, even the most enterprising surgeons thought it justifiable to attempt any operation on the brain, and how exclusively such operations were restricted to dealing with the visible and tangible results of localised injuries, it seems almost magical to read his address, and to know that these operations were undertaken, not only to relieve the immediate and direct effects of injury, but also as curative methods in the most various affections, some consequent on old injury, others, owning no known cause. With indisputable justice may Dr. Macewan claim the proud distinction of having been the leader in this country, and, we believe, in the world, of this great advance in our art."

Dr. J. B. Hamilton has well expressed our conclusions: "However interesting from an historical point of view to revive these lessons of the past, we must remember that as science is progressive, so the practice keeps equal step with that progress. In the past, practice was in advance of scientific knowledge. Tradition governed, instead of history and inductive reasoning. In the modern practice of the surgery of the brain and its envelopes, we have, indeed, little to offer that is new in the practice—the slightest glance at medical history forbids that conclusion—but the reasons for our method belong to us alone, and our century, although the heir of the accumulated wisdom of ages that are past, will have more to give to posterity in solid knowledge than any half dozen centuries that have preceded it, and particularly in the matter of diagnosis."

CHAPTER II.

TREPHINING IN INTRA-CRANIAL EXTRAVASATION, ABSCESS, CYSTS, TUMOURS, MENINGITIS, AND GENERAL PARALYSIS OF THE INSANE, &c.

Blood may be extravasated in several conditions as between the bone and dura-mater, within the arachnoid, in the pia-mater, in the structure of the brain, or in its ventricles. So far as the operation of trephining is concerned, the consideration must be confined to the two earlier conditions. Extravasation in the pia-mater cannot be diagnosed by any symptom, neither is there any possibility of removing an extravasation of this kind, whilst any extravasation of blood in the brain or in its ventricles of traumatic origin is generally rapidly fatal, and the symptoms would be those of apoplectic effusion.

Trephining in Intra-cranial Extravasation.

Holmes[1] says: "Extravasation between the bone and dura-mater depend either on laceration of the middle meningeal artery, or of the lateral or some other sinus. The symptoms of compression from this cause (when they are sufficiently definite to permit of diagnosis) come on after an interval of complete or incomplete consciousness. It usually advances rapidly, and in well-marked cases soon culminates in hemiplegia. When this is the case it is an indication, even in the absence of any history or mark of injury, which justifies the surgeon in cutting down (on the opposite side to that paralysed) on the large branch of the middle meningeal artery which crosses the anterior

[1] In his "System of Surgery," 3rd edition, 1883.

inferior angle of the parietal bone, since this is the vessel most frequently lacerated. But the hæmorrhage may proceed from other sources, as the lateral sinus; therefore the surgeon should be prepared, if necessary, to expose the posterior inferior angle of the parietal bone also. And there are cases in which these symptoms are due, not to the laceration of any known vessel, but of several unnamed branches passing from the dura-mater to the bone. Here, however, the known situation of the injury must be the surgeon's guide in applying the trephine, but the greatest difficulty is that very similar symptoms may follow on rupture of vessels in the interior of the brain from laceration of the cerebral substance. Nevertheless, as the symptoms of unilateral compression of the brain coming after an interval from the injury do undoubtedly often depend on the lesion of an accessible vessel, the trephine should unquestionably be applied in such cases, and all the more if any fracture is perceptible externally."

Holmes quotes several cases in which trephining has been done in this condition, and the operation has been most successful. He considers that traumatic extravasations of blood in the cavity of the arachnoid are the most common, that there are no symptoms which enable us to clearly diagnose an extravasation of this kind, but if symptoms of compression follow they will be the same as those of a collection of blood upon the outer surface of the dura-mater, and the surgeon may thus be led to apply the trephine under the supposition that the blood is in this situation, supposing the trephine has been thus applied and no blood found between the bone and dura-mater; still the blood in the arachnoid may chance to lie immediately under the spot, and the dura-mater, of a blue colour, may bulge into the trephine hole; under such circumstances blood in the cavity of the arachnoid has several times been let out and the patient saved. When, however, there are no indications of the blood in the arachnoid having been under the trephine hole, there is nothing to justify the surgeon in proceeding further.

Mr. Cock held that when the circumstances of the accident have exposed to view a fractured or depressed bone, or a lacerated brain, a careful examination of the local appear-

ances and the general symptoms will be sufficient to guide and determine our proceedings. But when, on the other hand, no breach has been made in the coverings of the cranium, we must often depend on symptoms alone, and the accuracy of our diagnosis as to the seat and nature of the mischief will chiefly depend on our knowledge of the principles of physiology and pathology. In most instances, however, a just conclusion may be reached from the history of the case. The man receives a blow, he afterwards becomes dull and drowsy, the pulse beats slow and full, he is roused with difficulty, and finally falls into a heavy sleep, with stertorous respiration and paralysis of one half of the body. Such a case is most probably one of compression from extravasated blood beneath the dura-mater, and due to rupture of some of its vessels. Should the symptoms come on in a few minutes and without fracture, either an extensive detachment of the dura-mater has occurred, or the blood issues from the large branches of the meningeal; if from the last cause, the clot will be located at the side and base of the brain. If the symptoms arise only after several hours or it may be days, there is reasonable ground to infer that the detachment of the dura-mater is at a point where the vessels are small and the flow very slow. The symptoms of compression from a blood-clot may be delayed in consequence of the collapse succeeding a severe injury, by which the heart is so enfeebled that the circulation does not reach the torn vessels with sufficient force to overcome the combined resistance of their clots and that arising from the retraction and inversion of their tunics. As soon, however, as reaction sets in, these coagula are displaced, the bleeding begins and the characteristic signs of compression appear. When in addition to the signs of compression there is present great restlessness with disturbance of the muscular system and convulsions, the case is probably one of laceration of the brain substance and constitutes a most unfavourable complication, one of which is by no means uncommon.

Mr. Hewett, stated that "the *post-mortem* records of St. George's Hospital show that within the last few years there have been twenty-five cases of large extravasation of blood between the bone and dura-mater, in all of which the brain was more or less extensively lacerated."

Agnew, of Philadelphia, in speaking of the symptoms, said: "The patient after a blow or fall upon the head passes into a condition of unconsciousness, the breathing, at first laboured, becomes stertorous and puffing, the cheeks rise at each expiration, and the pulse is full and slow, the pupils are dilated and there is paralysis and elevation of temperature on one side of the body. To these symptoms may be added retention of urine and frequent loss of control over the body. Irregularities are frequently seen in regard to the condition of the pupils after traumatic extravasation of blood; instead of being dilated, they may be contracted, or one may be large and the other small; the cause of the dilated pupil in compression is due to pressure upon the third cranial nerve. The pulse may also differ from the typical condition, and instead of being full and slow, may be small, frequent, and irregular."

A widely-dilated pupil is often found on the same side as the clot, and this symptom appears to be one well worthy of notice, though it must be confessed that our knowledge of the different conditions of the pupil, after injuries to the brain, is at present very imperfect. The increase of paralysis is indicative of pressure from increasing hemorrhage on the brain.

If a distinct interval of consciousness has occurred after the accident, and if there be anything at all to guide us to the side on which the hæmorrhage has taken place, I do not think we are justified in denying the patient the chance which the performance of the operation affords.

Macewen, in 1883, correctly diagnosed a traumatic intracranial effusion of blood from the motor symptoms exhibited, as being located over the base of the ascending convolutions. There were no external marks of injury, and the motor symptoms alone were the guides to the position of the lesion; the patient survived, regained robust health, and was able to attend to regular employment.

Another case recorded of trephining, for basal hæmorrhage,[1] and a most interesting case it is, by Professor Chiene on a patient of Dr. Andrew Smart. The professor gave us a *résumé* of the case at the Bournemouth meeting.

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[1] *British Medical Journal*, December 5th, 1892.

"I operated on a person comatose with Cheyne Stokes respiration, and a pulse of 40 to the minute and on the point of death. I feel justified in recommending that in apoplexy, an opening into the cranial and dural box is a justifiable surgical procedure; nearly twelve months afterwards she enjoyed excellent health and her intelligence was unimpaired." In this case there was an antecedent injury, and Professor Chiene at first trephined at the right parietal eminence, but finding the result negative again applied the trephine lower down and forward; there was free hæmorrhage from the membranes, but the breathing became normal and after incising the dura, there was evident relief to the cerebral pressure and tension.

Dr. Laplace, of Philadelphia, by a brilliant operation removed clots from the base of the brain and the patient recovered. The patient, a boy of 10, whilst at play fell on a broken fencing foil, which penetrated the left orbit, between the infra-orbital ridge and the eyeball. This was followed by unconsciousness, with deepening coma, right hemiplegia, left facial paralysis, complete aphonia, respirations 30, pulse 140, temperature 104.5°. The wound was explored without result, and thirteen days later trephining was performed low in the temporal fossa. To reach the centre of the base of the brain for the removal of the suspected clot, a miniature egg beater, consisting of four loops of platinum wire, had been improvised; with this he was able to remove a teaspoonful of clotted blood; whilst dragging out more coagula considerable venous hæmorrhage took place. The trephined opening was plugged with iodoform gauze; the wound healed in three months, and in six months the patient had equal use of both extremities.

Jacobson,[1] in a thoughtful paper, thus forms his prognosis, based on 70 cases:—

(*a*) The most Hopeful Cases for Trephining. Violence, comparatively slight; laceration of middle meningeal artery or its branches; fracture of skull, if present, slight and localised to side of skull, *i.e.*, not implicating the base; compression, but little or no contusion or laceration—27 cases.

(*b*) Less Hopeful Cases. Violence, greater; laceration

[1] *Guy's Hospital Reports*, vol. xliii.

of middle meningeal or its branches; fracture, implicating middle fossa; some injury to brain, but this only trivial—20 cases.

(*c*) Cases probably Hopeless from the First. Violence, very great; laceration of middle meningeal or its branches; fracture of skull extensive, perhaps implicating several bones and sutures both in the vault and base; injury to brain very severe—23 cases.

If no blood is found superficial to the dura-mater, this membrane should always be opened with a fine-pointed bistoury, especially if it bulge up, without pulsation; otherwise that much rarer condition, an infra-dural hæmorrhage may be left unrelieved.

The guide for the use of the trephine is the line of the sulcus of Rolando,[1] on the side opposite to that in which the paralysis exists; the seat of the paralysis will determine the exact spot on this line.

Lucas-Championnière gives the following rules for the application of the trephine :—

(1) When there is general hemiplegia the crown of the trephine should be applied across the middle of the line of the sulcus of Rolando.[2]

(2) When the arm and leg are paralysed the trephine should be applied to the upper part of the line, but not at its very summit.

(3) In paralysis of the upper limb only the trephine should be applied a little in advance of the middle third of the line.

(4) In simple aphasia it must be applied lower down, below and a little in front of the line.

(5) When the extremities are paralysed the top of the line and the vertex must be trephined.

(6) When the upper and lower extremities are paralysed, the middle and upper part of the line should be trephined.

(7) Paralysis of one upper extremity, with facial paralysis, requires trephining in front of the line at its lower third.

(8) Paralysis of one upper extremity, with aphasia, requires the trephine to be applied below and in front of the line.

(9) In facial paralysis and aphasia the trephine must be applied in front of the line and below its level.

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[1] Plate 16, page 49. [2] Plate 17, page 51.

In all cases a large trephine should be used, and if necessary it may be applied in more than one place.

He gives the rule for finding the line of the sulcus of Rolando: "A point 55 millimetres behind the junction of the coronal and sagittal sutures in the middle line, corresponds to the upper end, fig. 1, R.; to find the lower end, R.,[1] draw a line directly backwards from the external angular process of the frontal bone for seven centimetres, E.O. P.-A.; from the posterior extremity of this, draw upwards a vertical line three centimetres in length, A.R.;[1] the upper end of this corresponds to the lower end of the sulcus of Rolando.

Thane's rule: "The upper end of the sulcus of Rolando is placed about half an inch behind a point midway between the root of the nose and the external occipital protuberance; its lower end is close to the posterior limb and about an inch behind the bifurcation of the fissure of Sylvius. The bifurcation of the fissure of Sylvius corresponds to a point one inch and a quarter behind and a quarter of an inch above the level of the external angular process of the frontal bone."

Dr. P. Wiseman (Zurich) enumerates the causes of injury which produce rupture of the middle meningeal artery as follows:—Direct wounding of the vessel by sharp instruments, laceration by projectiles or fragments of bone; rupture by changes in the relative position of the surrounding bones (the most frequent course); rupture without fracture of bones in consequence of differing elasticity in the tissues, occurring especially on the side opposite the injury. Rupture having taken place, commotion of the brain prevents the flow of blood; but sooner or later hæmorrhage occurs and severs the dura (unless injured) from the skull. The clot may become putrid even when not exposed to the air.

The *symptoms* pointing to rupture of the middle meningeal artery are given as follows:—(1) Interval of consciousness between the concussion and the appearance of pressure symptoms; somnolence, stupor, coma, death. Pareses and infrequent pulse are often present, and sometimes irritation symptoms precede the latter unconscious state. Compression symptoms may occur at any time from fifteen minutes to eleven days, after the commencement of the hæmorrhage. (2) Hemiplegia on the side opposite the injury.

[1] Figure, page 49.

This is explained by the position of the artery exactly over the motor centres for the arm and leg. Isolated paralysis of the leg is never observed, but only paresis when the arm is paralysed; or both may be similarly affected at once. Convulsions may precede the affection. (3) Changes in the pulse; infrequency and hardness, generally increasing; sometimes the pulse becomes frequent at the last (paralysis of the pneumo-gastric nerve). (4) Anomalies of respiration, slow, embarrassed, stertorous breathing. (5) Vomiting. (6) Changes in the pupil; generally speaking, dilated pupils point to considerable pressure; the pupil on the side of the hæmorrhage is dilated and does not react. (7) Unilateral impairment of sensation. (8) Aphasia. (9) Disorders of the bladder and rectum. (10) Automatic movements and lying always on one side. (11) Rise in temperature.

The *diagnosis* is sufficiently accurate if the first four of these symptoms are present, whether there be a lesion of the skull or not, or even if there be one on the opposite side. Aphasia points to an extension of the hæmorrhage towards the front, disorders of the sensibility to one behind, paralysis of the third pair of nerves to one towards the base of the skull. Crushing of brain-matter, inflammatory conditions, even congestive hyperæmia, may cause errors of diagnosis.

The *treatment* must fulfil two indications—to stop the hæmorrhage and to relieve the brain from pressure. The question of ligating the artery and disinfection of the seat of the hæmorrhage, and the point of tying the vessel are next considered, and the line of treatment summed up as follows: Operative treatment is indicated (*a*) in cases of hæmorrhage through a wound of the skull; (*b*) in all cases of compound fracture; (*c*) in cases of sub-cutaneous fracture of the skull when the meningeal artery is ruptured, especially when the rupture occurs on the side of the injury, or even when there is no fracture; (*d*) the hæmorrhage is to be stopped by means of a ligature or with a suture. In case these methods are impracticable, tamponade with iodoform gauze is recommended; (*e*) the main object in operating is to entirely remove the extravasated blood and to thoroughly disinfect the cavity which it occupied.

The following indications represent the latest American views of trephining in cerebral hæmorrhage.[1] When there has been a blow upon the head, and hemiplegia, aphasia, or hemianopsia follows, there is nearly always a hæmorrhage which may be cured by opening the cranium at the point indicated by cerebral localisation. Paralysis of the third, fourth, or sixth pairs of nerves indicates a lesion in the pons and contra-indicates operation. A slight premonitory attack, affecting speech temporarily, or producing a heaviness of hand or foot for a few minutes, if followed by hemiplegia, may be taken as a good point in favour of operation, as the bleeding vessel is probably on the surface or very superficial.

Paralyses of a very limited extent, especially if complete, are not often due to hæmorrhage, being local palsies rather than the peripheral indicative of cerebral disease. A very severe headache, followed by gradually but rapidly deepening coma, and hemiplegia becoming more and more complete, means a hæmorrhage into the great basal ganglia, probably beyond surgical help. When the case presents a history of moderate loss of power or complete hemiplegia without unconsciousness, followed in a few hours by sudden appearance of coma, marked fall of temperature succeeded by some fever, a hæmorrhage has broken into the ventricles or beneath the membranes, is still progressing, and indicates immediate trephining; a day or two afterwards will be too late, so if done at all it should be performed within a few hours, if possible.

Very sudden and complete hemiplegia and coma (coming on as if the patient were struck with a hammer) usually means embolism; heart lesions, endo-arteritis, and syphilis strengthen the probability. Bilateral hemianopsia (blindness of corresponding sides of both eyes) appearing suddenly, is apt to be due to a hæmorrhage in the occipital lobe of the opposite side, and justifies exploratory operation. Profound coma and relaxation without any hemiplegia usually depend upon injury to the pons, and decide against operation. Vomiting, severe occipital headache and vertigo, with or without a distinct paralysis, render a cerebellar hæmorrhage probable. Ocular symptoms, like

[1] Dr. Lamphear in *Journal of American Medical Association*, 1893.

nystagmus and strabismus, are also apt to accompany these symptoms of cerebellar lesion; exploratory operation is justifiable. According to Hughlings Jackson, convulsions, early rigidity, and conjugate deviation of the eyes of a spastic form, are conclusive evidence of hæmorrhage. Convulsions always accompany hæmorrhage in young persons.

Trephining for Abscess in Brain.

Dupuytren may justly claim priority for trephining in this condition. His patient was admitted into the Hotel Dieu in a state of stupefaction into which he had suddenly fallen. On examining a scar a foreign body was clearly felt underneath it and on this being laid bare proved to be a point of a knife broken in in a brawl several years before. The trephine was applied, the symptoms nevertheless continued, and paralysis of the opposite side made its appearance. The dura-mater was now laid open, nothing was found under this membrane, a knife was therefore plunged into the brain, and immediately a large quantity of matter flowed out. That night all the symptoms disappeared and the patient ultimately recovered.[1]

During the last few years there have been many cases of recovery after deep-seated abscess of the brain of a chronic character treated by trephining incision and subsequent drainage. In many it has been possible to give antecedently a dogmatic opinion as to the presence and seat of the abscess, and in others its position in the brain has been successfully established by means of exploratory punctures after removal of a circle of bone.

A cerebral abscess, after evacuation and drainage, will heal like an abscess in any other situation, and correct localisation is favoured by the history or traces of an old head injury, or by the association of suppurative aural disease. Kocker has reported a case in which he opened and drained an abscess seated in the neighbourhood of the third ventricle.

The question as to the use of the trephine is one of no

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[1] Holmes' "System of Surgery."

small interest. Shall a way be opened for the escape of pus? Agnew tells us: "Pott performed the operation with five successes; Dupuytren, in one instance, opened successfully, which was beneath the membrane, one inch deep in the substance of the brain; Guthrie, one in the arachnoid, which was circumscribed; and Roux, as given by Hewett, one, probably in the brain. Noyes, of New York, emptied a collection of pus beneath the dura-mater, under circumstances not unlike those of Roux's case, the suppuration having followed a diseased bone in which a sinus existed. The closure of this sinus in Noyes' case was followed by epileptic convulsions, due to brain pressure from the accumulation of pus, and for this the trephine was used. The epilepsy was not cured though relieved. The patient died three years after of ceretrivitis. Jones and Chinault, of Richmond (U.S.A.) trephined the skull and evacuated an abscess with blood under the dura-mater, forty-two days after a fracture. The patient made a good recovery. Dutmold (U.S.A.) has carried his puncture into the lateral ventricle to reach a collection of pus, but the patient did not survive the operation."

There are several difficulties which environ this subject.

(1) Even when the symptoms follow a contusion of the head, such as rigors, delirium, stupor, and hemiplegia indicate the existence of suppuration; its exact locality is a matter of great uncertainty.

(2) The suppuration is often diffused, the result of an equally wide-spread meningitis.

(3) The symptoms on which the operation is based are often due to pyæmia, in which the general system is hopelessly involved; abscesses existing in the lungs, liver, sinuses of the brain, and other parts of the body.

It will be found that the successful cases of trephining for abscess have been, for the most part, those where the pus was beneath the bone, and external to the dura-mater, or where either a fracture or a sinus led to the exact locality, or where the pus was circumscribed.

Of the 17 cases mentioned by Holmes, which were left without operation at St. George's Hospital, all died. Therefore, with such an alternative, I should feel it my duty, where there are good grounds for believing in the existence of

suppuration, and with a reasonable conviction of its locality, to open the skull and give my patient the only chance, desperate as it is, which remains for his rescue.

The most favourable cases for operation are those in which hemiplegia exists, as it indicates a circumscribed collection. As to the proper place in which to apply the trephine, the judgment of the surgeon must determine the position after a careful consideration of the case. Should the puffy tumour of Pott be present, it must not be underestimated, and the incision should be made through the swelling to the bone.

With regard to the question—shall an opening be made into the brain at a venture, or shall the surgeon be content to wait for instructions by the future progress of the case? There are reasons for both courses. Roux once trephined for abscess, and not finding any collection after opening the membranes, proceeded no further; the patient died, after which an abscess was found almost on the surface of the brain. Petit trephined a child after a compound fracture without obtaining any pus and without any alteration of the urgent symptoms, though some bloody serum escaped; two days after an abscess found its way spontaneously to the opening and discharged, after which the boy recovered.

We need not err in either direction. In cases of such obscurity, the exploring needle, four inches long, attached to a hypodermic syringe, should be introduced into any suspicious locality, and if this invaluable instrument discloses a purulent collection, the bistoury must open the way for its escape; if not, all incisions are rash and unsurgical; puncturing the brain with an aseptic needle can do little harm. If the operator, with all these precautions, fails to find the abscess, what next? Unless some new development shall have occurred, which will render a second perforation more promising than the first, there is no indication for its repetition. There can be no justification for boring holes around the entire head, or at several different points, after the recommendations of Heister. Yet, Dionis taught that in extensive fractures three or four operations might be performed. He relates a case of a young girl who had fractured the whole of the parietal, and a part of the temporal, bone; the trepan was applied twelve times by

M. Maréchal, and all the bone that remained between the trepan holes was also torn away by the surgeon; by this treatment, Dionis adds, she was thoroughly cured. Thus it would seem that the old surgeons had some grounds for belief in the harmlessness of trephining. The reckless manner, however, with which it was resorted to in quite trivial affections has led to the disgrace of the operation, which was brought about in great part by the trenchant criticism and caustic wit of John Bell, one of the greatest, as he is certainly the most amusing, among writers on surgery.

Some mention should here be made of trephining for mastoid and cerebral abscess, the result of otitis media.

It seems pretty well admitted that this condition can only arise in old-standing cases of otitis media, with long-continued discharge and deafness; the probable symptoms will be pain in ear, temple or occiput, with mastoid tenderness, swelling, redness and œdema. If it be necessary to trephine, it is usual to make a T or crucial incision, and a small trephine is applied immediately behind the auricle, and the operation may often be completed with a small gouge. If the abscess is in the brain or cerebellum, the symptoms may be rather negative than positive. There may be mastoid suppuration, which has been neglected, a latent period, and then perhaps headache and vomiting, drowsiness deepening into coma; temperature may be subnormal and the pulse slow; paralysis of face, alteration of pupils, and ptosis may be later symptoms. The treatment is early trephining, with free drainage.

Of late years many cases of cysts of the brain have been recorded. The origin seems obscure; they have been thought to be due to dilatation of lymph spaces, or to a fœtal remnant. Symptoms have generally been those of paroxysmal headache, reeling gait, vertigo, impairment of power in arms or legs, optic neuritis—sometimes without loss of sensation—speech slurred, pupils dilated; strabismus has been noticed, with sickness and vomiting.

Macewen has reported several cases, which will be mentioned more fully under "Trephining for Epilepsy."

Dr. Graham and Mr. Clubbe[1] record an exceedingly in-

[1] *Australian Medical Gazette*, July, 1890.

teresting case of successful removal of hydatid tumour of the brain. The case was that of a youth aged 16, who suffered from severe headache, nausea, vertigo, double optic neuritis with atrophy, loss of memory, mental dulness and paresis of the right arm and leg. A tumour involving the left motor area was diagnosed, and Mr. Clubbe trephined over the arm area. He found the bone very thin, and on opening the thickened dura-mater a single hydatid cyst was seen and easily extracted; the pia-mater was intact. The cyst measured four inches in diameter, and held nineteen ounces of fluid. The patient recovered; after six weeks he was able to get up and walk, his memory returned, and in all respects he was well except for his blindness.

Trephining in intra-cranial tumours has been practised, and whilst the operation for their removal is not difficult, many of these neoplasms are malignant, and the result of the cases already published do not seem to warrant interference.

Meningitis will usually be a secondary complication of pus between the bone and dura-mater. We may have a plastic localised form; this is not unfrequently met with in cases of otitis media, especially over the tympanum and squamous bone, or over the sulcus lateralis in the posterior fossa; where it spreads from the roof of the tympanum up over the temporal lobe, it will be good practice to trephine, with irrigation and drainage.

Trephining for Meningitis.

Macardle[1] reports a case, the good results of which favour the view that trephining may do good, in some forms at least, of meningeal inflammation. In other regions than the head, when inflammatory tension is evidently leading to a fatal termination, relief is often afforded by incision and free drainage. The time has now arrived, this author thinks, when this principle may be applied in brain surgery. The patient was a coal porter, aged 40, who fell into the hold of a vessel, and struck the left side of his head; he remained unconscious for some hours, but on the third

[1] *Dublin Journal of Medical Science*, July, 1892.

day was able to resume his work. There was no trace of injury to the right side of the scalp. The patient continued at his laborious occupation for sixteen days, but after this interval suffered from nausea and pain in the head; soon afterwards he lost the use of both limbs on the left side. Four days later he suffered from severe convulsive attacks, each beginning with firm flexion of the fingers of the left hand. As death was imminent from laryngeal spasm, a small disc of bone was removed from the skull on the right side over the upper end of the fissure of Rolando. Serum, not blood, was found to be the immediate cause of the pressure symptoms; after removal of the piece of bone, the dura-mater projected into the wound. On incising this, a greenish fluid gushed out, the membranes were thickened, and showed that meningitis had been set up. The man made an uninterrupted recovery, and went back to his work one month after the operation.

This case is certainly a triumph for modern brain surgery, yet I think trephining in meningitis will, for the present, remain an operation which is contained in the principle *Est ubi confixit metem temerè acta sagitta.* I have lately had a case under my care of a man, aged 27, with an incised wound extending down to bone situate over the left frontal eminence, and said to have been received from a blow from the barrel of an old rifle. In staggering home he fell up to his waist into a ditch containing water. On the third day after I found pneumonia; six days later he developed erysipelas of the wound, and he died ten days after receiving the injury. On *post-mortem* examination, under the pericranium I found a fine line of fracture of the thickness of a hair through both tables, extending in a straight line from the lower edge of the wound one and a-half inches, and then curving off to the left, passed through the superciliary ridge into the left orbit. On division of the membranes the vessels of the brain were found extremely congested, and the upper surface of the convolutions covered with recent lymph. In this case I fail to see how one or more openings down to bone and flushing the convolutions to attempt to remove the lymph would have secured a more favourable termination of the case.

CHAPTER III.

TREPHINING FOR EPILEPSY, PARALYSIS, IDIOCY, AND MANIA.

Here I would speak of maladies which, though belonging to the sphere of the physician, sometimes need the hand of the surgeon for their adequate treatment. The discoveries of Broca, Hitzig, and Ferrier have guided the hand of the operator more and more surely to the possible site of a traumatic cause of epilepsy, of an intra-cranial abscess or an exostosis of bone.

Of course, in ordinary idiopathic epilepsy, trephining is not practised, for its origin is still unknown, but in the Jacksonian form, "where the attack begins with a conscious sensation in some particular region of the body, either in one half of the face or in one extremity, the sensation is followed by a twitching of the muscles of the part, and the sensation and spasm advance gradually from the part originally affected to other parts in a definite order of progress. Thus, from the right half of the face down the right side of the neck to the right arm, and lastly to the right leg; or in the reverse order from leg to arm, and then to face, or from the arm upwards to the face, or downwards to the leg. During such an attack consciousness is not usually lost, though it may be lost when the attack culminates in a general convulsion. Jackson maintained that this form of epilepsy was uniformly due to organic disease of some kind situated in the convolutions adjacent to the fissure of Rolando, and it is now proved conclusively that disease of an organic character located in the motor

region of the brain will uniformly cause Jacksonian attacks. The character of these attacks, their mode of onset, and the order of their progress depend entirely upon the exact position of the initial irritation in this motor area. If the irritation is slight, it may be limited to a small region, if more severe it extends to adjacent regions. This extension may be likened to a ripple on a pond when a stone is thrown into it. The ripple spreads from the centre to the very limits of the pond, but the little waves get lower as they get farther away from their point of starting. Irritation in the brain is likewise always more intense at the seat of excitation, and grows less severe as the irritation reaches other centres at a distance."[1]

Trephining for epilepsy dates back to the middle of the seventeenth century. Echeverria, in two papers in the *Archives Générales de Médicine* for 1878, collected 145 cases where the trephine was used for the relief of epilepsy, and it is easy to make this number up to three hundred by cases since reported in the various medical journals.

In a very large number of these the lesion was a gross one, being either a compound fracture of the skull, or an extensive syphilitic caries or tumour connected with the dura-mater, but in others where trephining has been practised at the site of an old fracture, nothing may have been found but abnormal thickening, and perhaps slight condensation of bone. Again, long periods may have elapsed between the injury and the onset of the disease, and doubt may arise whether the injury and the disease stand in the relation to each other of cause and effect. In one of Echeverria's cases, the fracture of the skull took place in infancy, and the epilepsy did not show itself until the patient was eighteen years old.

Trephining for epilepsy following injury of the skull is no new operation. Lately such treatment has been largely employed, not only in cases where there has been an old fracture or contusion, but in those in which, by application of the rules of cerebral localisation, it has been possible to determine the place of a meningeal thickening, or of a limited chronic encephalitis, or a new growth, solid or

[1] Starr, "Brain Surgery," 1893.

cystic, acting as an exciting cause of motor disturbance. Electrical stimulation as recommended by Horsley, by means of two delicate electrodes about an eighth of an inch apart, are applied directly to the exposed cortex, and passed over it until the portion is found which produces the spasm in the muscles corresponding to that initiating the convulsion. The attained perfection of operative procedures has reduced greatly the rate of mortality, and even the after presence of an opening in the skull has been prevented by a re-implantation of the removed bone. Unfortunately, in very many cases of recovery from operation, which in itself appears with antiseptic precautions free from danger, in a few weeks or months, or it may be years, the convulsive seizures will come on again. An established "epileptic habit" is independent of the original lesion, and after a certain undeterminable period the patient can no longer be assured that, the cause removed, the effect will cease. Nevertheless, the morbid condition is so disabling, the relief afforded may be so great, the risk run is comparatively so small, that after proper, and properly continued, yet unavailing medical treatment, an epileptic in whom the seat of the disease can be fairly well located may well become the subject of operative interference.

Dr. Sachs[1], in answer to the implied question, What can we expect from the surgical treatment of epilepsy? says: "Simple trepanation seems to be more successful in these epilepsies associated with infantile palsies than in the traumatic forms; probably because of the still greater frequency of cysts in these cases than in the traumatic forms, 44 per cent. of all cases of infantile paralysis develop epilepsy. Of all cases of epilepsy a very fair proportion were developed in connection with infantile palsies. As soon as epileptic symptoms appear the paralysis has the value of a focal symptom. In children, excision of a centre is a less serious affair than in the adult, for in the former other parts of the cortex are capable to a greater degree of assuming the functions of the destroyed part. Under favourable conditions the surgeon may be able to cure a few cases of epilepsy, he will be able to improve many."

[1] *New York Medical Journal*, February, 1892.

The earlier the operation is performed and the nearer to the first appearance of the nervous symptoms, the more assured will be its success. The success of the operation depends also upon the age of the individual, and from this point of view it may be said that there is an inverse ratio between the age and the success of the operation.

Considering the vast number of cranial injuries from all causes, epilepsy, as a consequence of such, is rather uncommon. While depression is not a necessary antecedent for the production of epilepsy, in a large majority of cases under this head such a state of the bone is seen to exist. This affection is often preceded by defective memory and articulation, and by inability to sustain any connected train of thought, or transact ordinary business. After some time there may follow a momentary loss of consciousness, or a peculiar, indescribable sensation in the head, and, finally, the development of true epileptic convulsions. Should the trephine be applied to excise old depressed portions of bone, which by irritating the membranes of the brain, and the brain itself, provoke this distressing disease? La Motte, seventy-five years ago, was the first to use the instrument for this purpose, and there can be no doubt that under certain conditions the operation is not only proper, but even urgently demanded. It is the apprehension of this disease that induces some surgeons to apply the trephine in cases of depressed fractures, even when no urgent symptoms are present.

In a paper by Dr. Billings on the subject of trephining for epilepsy, sixty-two cases are collected, of which number forty-two were cured, sixteen died, and four remained without any improvement. Professor Gross has operated four times with one cure.

Dr. Agnew trephined in three cases of the disease; one recovered, one greatly relieved, and one died. The depression of bone in two of the cases was well marked.

He further collected 57 additional cases with the result 4 cured, 32 improved, 9 not improved, 4 result not known, 4 died. Laurient collected 102 cases; 54 cured, 20 improved, 17 not improved, 2 made worse, 7 died. Starr collected 42 cases, of which 13 were his own. Of the total cases 13 died, 11 improved, 15 not improved, 3 died. He

says statistics are chiefly of value in demonstrating the safety of the operation, and when the result of these cases is reviewed it is evident that in the majority there has been a failure to permanently cure epilepsy by operative interference. When we raise the question why the operation has failed, the obvious reply is offered that the original condition which gave rise to the fits has not been removed. It is, of course, quite possible to elevate depressed bone, to remove a cyst, or take away any mass of connective tissue or tumour which compresses the brain. But on the other hand it is useless to break up adhesions between dura and pia or between pia and brain, because they will inevitably reform immediately after the operation. Nor is it possible to accomplish anything when the pia and cortex are together affected by such connective tissue changes. Fine trabeculæ of connective tissue entering the cortex from the pia, and forming a dense scar-tissue in and about the motor cells, give rise to an irritation which can only be removed by the excision of the mass. But excision of such a mass, together with the brain, or excision of a softened mass of brain, is inevitably followed by a formation of a connective tissue cicatrix, which in turn will act as an irritant. Thus, the pathological conditions met with in these cases are frequently such as to make any possibility of a relief by an operation out of the question. I think the fact that the underlying organic brain disease producing the epilepsy cannot always be eradicated by an operation, fully explains the failures which have been recorded by so many observers. The question then arises, shall we continue to trephine any cases of traumatic or localised epilepsy ? Judging by general results which are unfavourable, we should incline to stop. But when it is taken into consideration that in no case is it possible, without an operation to determine the exact pathological condition present, and that a certain proportion of the pathological conditions are removable, it is evident that an operation, if not attended with danger, may be reasonably undertaken. Some patients have undoubtedly been cured. The statement should be made to the patient: " You have a brain disease that is causing fits ; that disease may be curable by operation ; we cannot tell whether it

is curable until we operate; we cannot promise that the operation will in any way benefit; a majority of chances are against cure, but it is the only method of treatment which affords any hope whatever, and it is a method which is fairly safe."

Echeverria, in his work on trephining for traumatic epilepsy, quotes eighteen cases, out of which only three ended fatally. Ziemssen, in his "Cyclopædia of the Practice of Medicine," says: "Although adopted in former times most extensively in every case which resisted medical treatment, and although warmly recommended by Tissot, in the course of time it has been continually less and less frequently practised. It is certainly true that in individual cases the disease was cured, and these brilliant successes, rare though they were, have always been an incentive to further trephining; even Echeverria reports three striking cases regarding the ultimate effect of which, to be sure, nothing can yet be said, because an immediate arrest of the seizures proves nothing. But even if it must be conceded that all the favourable cases were not those merely of symptomatic epilepsy, that, in other words, trephining may become a causal remedy (*e.g.*, if exostoses from an injury to the cranial bones have led to true epilepsy), though not necessarily so any more than in the case of excision of a peripheral cicatrix, still, in any given case all influences should always be most carefully weighed, as an absolutely certain diagnosis can never be established even under the conditions that we are here considering. Consequently we cannot with Hasse "urge that any indication whatever that warrants trephining should be followed," but we are willing to grant that the operation, in accordance with our present experience, is generally allowable, and we must regard its success in any particular case as "a piece of good fortune which could not have been predicted."

Mr. Bellamy trephined over the fissure of Rolando with success in a case of epilepsy following an injury received thirteen years previously. The fits ceased after the operation; one or two occurred subsequently, probably from the formation of an abscess.

Mr. Cooper Forster had a successful case of trephining

for traumatic epilepsy; the fits diminished after the operation, and at last ceased.

Mr. Jonathan Hutchinson, who has had several successful cases, says, "Trephine at the seat of injury in preference to endeavouring to find a place for operating by anatomical reasoning." He considers the operation of trephining is in itself not attended by much danger, whether performed with or without antiseptics.

In an interesting case, the indications which led Dr. Macewen to expect "the probable locus of brain pressure" were—

(1) The contraction and fixity of the left pupil.

(2) The presence of a supra-orbital tumour of a gummatous character, and of a small nodule of probably similar consistence on the left side of the frontal.

(3) A fixed dull pain on the left side of the brow between these two tumours. Convulsions commencing on the right side of the face, and afterwards involving the right side of the body (though ultimately becoming general).

The case is a very successful one and encouraging, especially as the operation and its result enabled the patient to return to her work and earn her living, with no return of the epilepsy.

When called upon to operate for recent injuries to the skull, the surgeon often balances in his mind the additional risk the patient may undergo by the use of the trephine, and, not unfrequently, when the patient dies unrelieved, may again question how far the operation contributed to this end. But in such cases it is impossible to separate the antecedent damage from the additional risk, and a conscientious surgeon may lay to his own account that to which he contributed nothing.

The value of the reports of these cases is great if they should aid to form a basis for that courage which has its foundation in knowledge.

Dr. Alexander[1] "considers where psychical causes are in the ascendant, an entirely irrelevant operation may produce a good effect for a long time, but in these cases we

[1] "Trephining in Epilepsy in Doubtful Cases," *British Medical Journal*, 1893.

must beware of the recoil that sometimes occurs with such severity as seriously to endanger life. In some of these cases, however, a complete cure is effected by the improved condition of the nervous system that results after an operation through hopefulness, the fresh interest taken in life, and the strong belief that a cure has been effected. But even with the best, severe misfortune may at any moment precipitate a relapse. Where the psychical causes are important, but not so prominent, improvement only is obtained. In other cases an irrelevant operation fails to produce any effect, the causes of the disease are too deep to be reached by any moral influence, the patient indeed being sometimes quite ignorant of the fact that he is an epileptic, and the attacks coming on as usual during and immediately after operation.

"The use of the trephine in epilepsy may depend on speculation, or on a definite diagnosis. Like abdominal surgery, it may be exploratory or operative. The speculation cases are those where medicine has failed, and where mental dulness, imbecility, paresis, or other grave symptoms are threatened. We then grasp at a scar, a depression of the skull, a painful spot, a doubtful aura, a hazy localisation of onset of attack as a clue, and as a relief from our helplessness, and remove a portion of the calvarium over the suspected area. This operation is a perfectly harmless one. I generally perform it by making two large trephine apertures at the extremities of the area to be removed. By means of a spatula-shaped instrument or blunt dissector the dura-mater is separated from the calvarium round the apertures; then the area we intend to remove is marked out with a Hey's saw. It is only necessary to saw through the external table, when a strong pair of bone forceps readily completes the removal of the enclosed area of bone, the dura being separated as we proceed in our removal of bone. During the operation the wound is kept well moistened with weak perchloride lotion (1 in 3,000) and the flap may be replaced without drainage, and with good hope that union by the first intention will take place. Bone may be replaced or not, according to the principles on which the operation is conducted. By such an operation we can ascertain whether any cicatrix,

adhesion, bony spiculæ, tumour of brain or of dura-mater exists, or whether there is an excess or lack of intra-cranial fluid. We have removed the impenetrable bony barrier, and palpation and vision have now more power to enable us to form a diagnosis. When we find nothing that would warrant us in going any further we finish the operation, not without hope that benefit may accrue, and benefit is sometimes obtained to a very remarkable degree. But how? Well, that we generally do not know, but we guess at explanations. We may have removed a cicatrix, an adhesion. We have certainly performed an operation, we have abstracted a small quantity of blood, we have left a sore, we have diverted the patient's attention, we have relieved the pressure on the brain, we have increased the pressure on the brain, we have altered the diet of the patient, kept them under strict supervision, paid attention to the *prima via*, kept them at rest, free from excitement, and under conditions where their tempers, passions, and desires are restrained. Out of these and other explanations each reader takes his choice, according as he is a physician, surgeon, enthusiast, cynic, scientist, or quack. The chief thing for us, however, is to get hold of the facts of these cases, but these are just some of the things there is no getting hold of. Up to a certain date we hear of them, and afterwards a silence as profound as the grave is maintained."

It is probable that trephining for epilepsy was performed in olden days, in the remote past; this I have previously mentioned as a sort of sacred rite, and it is likely that its success in "casting out evil spirits" was due to the removal of exciting causes, as in this case. Finally, this should not preclude surgeons from gaining all the help they can from localisation in determining the seat of intra-cranial abscesses, where, indeed, the trephine can be regarded as the only means capable of rescuing from death.

Some mention must be made of trephining in general paralysis of the insane. Dr. Clay Shaw [1] recommends the propriety of surgical interference on two grounds: *general* in relieving pressure and draining off the fluid that has

[1] *British Medical Journal*, September 12, 1891.

accumulated, and *special* in the hope that it will afford a new system of nutrition for the brain, and another channel for the elimination of waste products.

The operation introduced by Dr. Shaw does not appear to have met with much enthusiasm. Dr. Batty Tuke refers to three cases, and reports a fourth. The history of the latter "is much the same as that of all others which have been trephined for intra-cranial pressure following on general paralysis." So long as fluid can drain there is relief of symptoms, but so soon as the wound heals they return, and the disease runs its course. Hence he holds that we should aim at obtaining permanent drainage, but this cannot be done from the surface of the skull, and we cannot reach the reservoirs of cerebro-spinal fluid at the base for anatomical reasons. He therefore advocates laminectomy of the second or third lumbar vertebra, with drainage of the pial sac by horsehair. Dr. Duncan, of Edinburgh, has recently performed this operation for traumatic injury, removing eight ounces of fluid daily for three weeks, with ultimate recovery.

The operation is, of course, based on the theory that the symptoms of general paralysis are due to an active inflammatory exudation, and that the excess of cerebro-spinal fluid here found is not the result of a mere compensatory exudation—a theory which is not by any means universally accepted. Even at best it can only be palliative, and to become practical may we not ask what good can come for extending life in those suffering from a disease so painful, wearying, and hopeless ?

Dr. Macpherson and Mr. Wallace, F.R.C.S.E., have recorded their experience;[1] they considered the operation justifiable, because the pathology of the disease seemed to mark it as capable of relief by surgical operation; that further acquaintance with the results of operative interference was desirable in the present state of our knowledge, in the face of the present safety of operative treatment; five cases were operated upon and all recovered, four cases showed marked improvement lasting from one to three weeks; the result of their experience, that no permanent or marked benefit was conferred on the patients.

[1] *British Medical Journal*, July 23, 1892.

The indications for trephining in epilepsy, provided that medical treatment and the removal of peripheral irritation fails to cure or relieve, may be thus classified:—

(1) In the distinctly traumatic epilepsies following depressed fractures and other lesions of the skull.

(2) In the traumatic epilepsies, in which the only visible lesion consists of a scalp wound that is sensitive or tender, and upon which pressure develops either an aura, vertigo, or an epileptic seizure.

(3) In all epilepsies, whether trumatic or not, in which the character and development of the seizures is such as to indicate a definite motor area as the seat of a cortical lesion.

The contra-indications: Cases of epilepsy of long duration with marked mental degradation, or in which, from the first, the seizures had been general and sudden, or where the general symptoms indicated an extensive cerebral degeneration; and also in cases where, in addition to any or all of these conditions, there was nothing in the symptoms or history of the case to indicate a definite or circumscribed lesion of the cortex that could be reached or removed.

As regards the whole subject of trephining in epilepsy, whilst there is much reason for satisfaction with the result of surgical treatment, perhaps one of the plainest lessons taught by the experience of later years, is that of the added difficulties and dangers that arise from unnecessary delay in resorting to surgical treatment. Certainly in traumatic epilepsy it is unwise to wait until the increased frequency of the seizures have reduced the patients to an imbecile or idiotic condition before adopting surgical methods of relief, as by so doing we greatly retard the chances of recovery. Cases of traumatic epilepsy invariably tend to grow worse, and are little, if at all, influenced by medical treatment, and are also usually accompanied by distinct enfeeblement of the intellect; as Echeverria forcibly puts it, "once declared, traumatic epilepsy, caused by injury to the head, leads to early insanity or to enfeebleness of intellect."

We should not overlook the curious fact brought out by Dr. J. W. White, of Philadelphia, in the "Annals of Surgery;" from a mass of facts presented, he quotes 56 cases of trephining for epilepsy where the operation showed

nothing to account for the convulsions, and yet 25 of these apparently successful operations were followed by cure, and 18 were benefited.

Useful information on this subject is given by Walsham,[1] from which the following five headings are taken.

(1) *Local indications calling for trephining.*—In 44 out of 82 cases the scar or spot was painful, tender and sensitive; pressure in some cases caused vertigo, convulsive fits, rigidity, or spasmodic twitchings of some group of muscles. In 8 there was a fistula leading down to bare bone. In 3 a fissure existed.

(2) *Cause, nature, and situation of the head lesion, to which the head lesion was ascribed.*—In 72 out of 82 cases there was a distinct history of some lesion to the head. In 46 out of the 72 there was a fracture, which in 26 out of the 46 was compound and depressed. The exact seat of the lesion is not given accurately in a large majority of the cases. In 45 it was over one or other parietal, in 14 over the frontal, in 3 over the occipital area.

(3) *Time of onset, duration and character of symptoms.* The time at which the epilepsy followed the injury varied greatly; in the majority this took place after a variable period, even as much as thirteen years. The shortest period was within a few hours. The duration of the epilepsy, when this was established, varied from a few days to twenty years. In nearly all the long-standing cases the fits increased in severity, the intervals growing less. In a large majority of cases, in addition to the fits, loss of memory, moroseness, delusions, even utter imbecility or violent madness, constant headache, and paralysis presented themselves.

(4) *Condition of the parts found at the operation.*—In two-thirds of the cases the bone was found either depressed or variously altered or diseased. Thus it was thickened, spongy, carious, necrosed, a fistula often co-existing in the two latter; depression, when present, often took the shape of the spiculum. The dura-mater in the greater number of cases was healthy, but in some congested, thickened, vascular or adherent. In 16 cases nothing was found at the operation to account for the epilepsy; 10 of these 16

[1] *St. Bart's. Hospital Reports*, vol. xix.

recovered and 7 were cured. It is difficult to say how the trephining cured in these cases; the symptoms had lasted many years, and yet ceased after the operation. In one case, although nothing was found at the operation, a spiculum was found at the *post-mortem* examination not far from the trephine hole; thus pointing to the advisability of sweeping a probe, carefully, with aseptic precautions, around the circumference of the trephine opening and at some distance from it.

(5) *Results of the operation.*—These are eminently satisfactory; out of 82, 48 were completely cured and 13 relieved; of the latter some may have been quite cured, after a longer interval and on the other hand some of the former may have relapsed.

Causes of failure after trephining for traumatic epilepsy.[1] —Not hitting off the right spot, an undetected bony spiculum, a general and diffuse thickening round the site of injury; owing to a long continuance or to the amount of the irritation the brain may be permanently affected, idiocy or mental weakness persisting; from alteration in the membranes or brain itself too extensive for removal; neglect of after treatment; fits not epileptic in character; a septic condition of the wound. Finally, in cases of doubt and where the operation has failed, the interference of the surgeon will be justified by the fact that traumatic epilepsy tends to grow worse, and is little affected by medical treatment, and leads to early insanity or to feebleness of intellect.

The indications for trephining are thus tolerably clear, and the results have often justified the means. As a rule the operation is called for whenever coma, spasm, or any irritative signs due to circumscribed lesion of the skull, or immediately subjacent structures, continue or endanger life in spite of all other treatment. And the benefit which has often been derived by removing a piece of the skull to relieve intra-cranial pressure, or to elevate depressed bone, or to give exit to accumulated fluid, has shown that its effects are not merely negative. But although this extreme measure must only be a last resort, it will often be

[1] Jacobson's "Surgery," p. 191.

rendered nugatory by deferring it too long, so that to be of any avail the most favourable opportunity must be taken for its adoption. In one case the amount of bone removed by the trephine was hardly sufficient to remove all the pressure that the thickened bone had caused. During the four years an epileptic habit had been acquired by the brain, which habit could not be immediately overcome, but would for a long time remain and exhibit its influence when an exciting cause called it forth, for whenever the youth became depressed, either by diarrhœa or by want of sufficient nourishment, the report tells us, immediately the attacks recurred. I wish to lay particular stress on an interesting point—that recovery from traumatic epilepsy cannot be immediate upon the removal of the pressure unless the operation be performed almost immediately after the accident which brought about the pressure. The reason of this is obvious ; a habit of epilepsy is set up, and, with the habit, structural change occurs in the brain and medulla oblongata. This change requires time to recover, after the first cause, namely, the pressure of bone, has been removed. Of course, the longer trephining is delayed, the less chance is there of perfect recovery, and the greater amount of change in the brain and medulla, the greater the improbability of recovery.

CHAPTER IV.

TREPHINING IN GUNSHOT WOUNDS OF THE HEAD.

Military surgeons from time remote, when implements of war received an immense impetus by the employment of gunpowder down to the present day, have taken the most lively interest in this subject.

The difficulty of comparing cases of injury to the head, as told to us by Guthrie and Hannon in the time of Waterloo, and the present, is increased by the alterations in the gun carried by the soldier, from an ordinary musket to a breach-loading arm with its graduated aim and rifled barrel, whilst the alterations in the arrangements for carrying the wounded off the field to the bare hospital, along with the great improvement in the nursing, and the attempt to dress wounds on the field antiseptically; but this comparison may be helped when we bear in mind the treatment this class of wound received from irritating compounds applied in ignorance, along with the absence of cleanliness and bad sanitary arrangements.

There is no doubt the magazine rifles will multiply the number of very severe wounds within limited distances, and owing to their larger range and greater accuracy, will increase the general number of wounded by extending the fighting area, whilst the means of aiding the wounded will be pushed back further into the rear.

Surgeon-General Sir Thomas Longmore, C.B., late Professor of Military Surgery, Netley, has pointed out that attention has been frequently directed to the difficulties in the way of deciding upon the cases of gunshot injury to the cranium which call for trephining, *i.e.*, under what condi-

tions the operation may be reasonably calculated to benefit a patient, and under what others the patient's welfare will best be attained by abstention from trephining. There has been for many years past a gradual disuse of this operation in the treatment of gunshot injuries in military practice. There is evidence enough to prove that, at the latter part of the last century, it was constantly employed. It was resorted to as a preventive measure in cases where no grave symptoms were present; even in simple cases of gunshot contusion of the skull, without cerebral symptoms having been evoked, the performance of this operation was authoritatively advised with a view to prevent inflammatory consequences. Trephining gradually declined in estimation during the time of the Peninsular Wars, and in Europe has become more and more restricted since, until, as regards some of the most recent wars, the Italian war of 1859, the war of 1866, and the Franco-German war of 1870-71, it was hardly employed at all; and in the few recorded cases in which it was employed, was mostly attended with unfavourable results. There was a large experience as regards this operation during the United States War of the Rebellion, as many as 200 instances of trephining for gunshot injury having been tabulated in the surgical history of the war. But even this number must not be accepted as showing that trephining was relatively a frequent operation in the United States. As a fact, the proportion of cases of trephining to gunshot injuries to the head, of all kinds, was larger in the Crimean War during the period that the records can be relied upon—from March 1, 1855 to the end of the war 3.11 per cent. in 898 cases of gunshot injuries of the head—than there were during the Four Years' War in the United States, where they were not quite 2 per cent. in 10089 injuries of the head. But the proportion of recoveries was far greater in the United States. In the Crimea the recoveries were only 14.28 per cent., while in the United States they were 42.5 per cent. This has really, to some extent, re-opened the question of the propriety of trephining in gunshot wounds, for it has become a matter for consideration in the minds of some surgeons whether the operation might not be more frequently employed with advantage than it has been of late years. A

hope has been entertained that, with the development which cerebral localisation has received from the investigations of late years, the particular seats of intra-cranial lesions, as indicated by symptoms, might be determined more accurately, and surgeons thus guided to the special parts of the cranium where the trephine might be applied with fair prospect of affording relief. Unfortunately, in severe gunshot wounds such as would be likely to raise the question of trephining, there usually exist such complications and such mingled symptoms that the precision hoped for from the scientific knowledge just alluded to can rarely be attainable. Even when the large practical experience gathered during the United States War is studied, it becomes apparent that, in many of the cases in which trephining proved successful, there were no more grounds for anticipating success as regards the symptoms presented, than there were in numerous others in which the operation proved unsuccessful. It seems well, therefore, to preserve a record of every instance of trephining for gunshot injury where there has been an opportunity of observing the particulars of the case with sufficient care.

Holmes says, "Fractures with depression are usually fatal unless the depression is very slight, since the brain is generally injured. And penetrating wounds are still more certainly fatal; out of seventy-six cases recorded in the Crimean War none survived."

Trephining should, in the opinion of the English military surgeon, Professor Longmore, as a general rule be avoided. He says: "Two or three instances are known in which the course of a ball has been traced from the site of entrance across the brain, and trephining resorted to for its extraction with success, but there are also many others in which the mere operation of the extraction of a foreign body has apparently led to the immediate occurrence of fatal results. Moreover, splinters of bone are not unfrequently carried into the brain by balls, and these may elude observation, or the ball itself may be divided and enter the brain in different directions, as was observed in the Crimea, when trephining can only be an additional complication to the original injury without any probable advantage. Where irregular edges, points, or pieces of

bone are forced down and penetrate—not merely press upon—the cerebral substance, or where abscess manifestly exists in any known site, or a foreign substance has lodged near the surface, and relief cannot be afforded by the wound, trephining may be resorted to for the purpose, but the application of the operation even in these cases will be very much limited if certainty of diagnosis be insisted upon."

Dr. Agnew (in his "Principles and Practice of Surgery," 1878) differs from Holmes quoted above. He says that in the Crimean War out of seventy-six cases of fracture with depression, and without penetration fifty-five died. The statistics of the late American War show a difference of 5 per cent. of perforating over penetrating fractures. When, in addition to the fracture there is depression of bone with the symptoms of brain compression, we have a complication which involves the exercise of much surgical judgment. The great question to be determined is this, when should the trephine be used to elevate the depressed bone? Upon this point there is some discrepancy of opinion.

There are conditions in which the indications for operative interference are plain and admit of no discussion, as where there is an external wound with comminution of the bone, its fragments being driven in upon the brain, with or without symptoms of compression being present; or where there is depression with the signs of compression steadily increasing, even though there is no external wound. In punctured wounds there can be little doubt about the propriety of using the trephine in order to allow of a free escape of blood and inflammatory products. A diversity of opinion might occur in those cases in which, with marked depression, the signs of compression are not urgent. The frightful fatality which has followed the employment of the instrument in such cases has greatly restricted its use with military surgeons.

Stromeyer states that in one of the battles of the Schleswig-Holstein War there were eight depressed fractures of the skull with moderate symptoms of compression which were left to nature, and all of which, with one exception, recovered. In the case which proved fatal there

had been some meddling, as a number of pieces of bone were extracted several days after the injury. During the entire war only a single instance of recovery followed the use of the trephine.

The experience of English surgeons during the Crimean War harmonises with that of Stromeyer, only four cases of trephining having recovered. With the French, as stated by Dr. Schrive, the operation was unsuccessful. Dr. Williamson tells us that after the Sepoy mutiny in India no soldier who had been trephined reached Chatham, although there were among the number eight cases of fracture of both tables of the skull with depression. In the late Franco-German War the operation was rarely performed. In the War of the Rebellion (U.S.) the results of the operation as they are recorded in the "Surgical History of the War," are quite favourable to the use of the trephine, and in striking contrast with the general experience of military surgeons abroad. The operation was performed in 220 cases, 95 recovering, 124 dying, and one result unknown, giving a death-rate of 56.6 per cent. In 454 cases the broken or depressed fragments were either removed or elevated by other means than the trephine, 275 of which number recovered, 176 died, and 3 remained uncertain, a death-rate of only 39 per cent. Flattering as these results appear until, however, we have ascertained, approximately at least, the exact nature of these injuries for which the operations were done, both as to the structural damage and the cerebral symptoms present—considerations which the distinguished author of the work himself fully recognises—it would be unsafe to speak with confidence on the subject, and especially where the weight of English, French and German military surgical authorities is directly antagonistic. I am inclined to believe that the truth lies somewhere between these two extremes, and that while the European practice has been too restricted, the American may have been too meddlesome.

I cannot believe that the operation of cutting out a circular piece of bone from the skull is in itself serious, so long as the dura-mater is not torn, any more so, indeed, than that of excising a portion of a rib, and exposing the pleura costalis. The success following the use of the tre-

phine when employed by the older surgeons for injuries of the skull, as compared with that realised by those of the present day, argues no superiority of judgment or skill on the part of the former, but simply proves that the old round ball was a harmless missile compared with the modern conical one. The dangers arise from the original injury, and consist in the damage sustained by the brain and its membranes.

In a paper by Dr. S. W. Goss there is a comparison instituted between the treatment of gunshot wounds of the skull by trephining and that by expectancy, with the following result:—In 160 cases of such injuries, in which the trephine was employed the death-rate was 60.62 per cent., and in 573 cases, in which the expectant plan was adopted, the mortality was 74.34 per cent. In 126 cases in which fragments were extracted or elevated by instrumental means, withour boring the skull, the mortality was 55.55 per cent. Comparing the results of trephining with the other modes of lifting or removing portions of bone, such as the elevator, forceps, or saw, the difference in favour of the latter is 5.07 per cent. of recoveries. The rate of recovery after all operative means was 41.61 per cent. By expectant or conservative methods the ratio of success was only 25.26 per cent., thus showing a result of 16.35 per cent. of recoveries in favour of the operative treatment.

Dr. Otis, in his interesting work on gunshot wounds during the Civil War in America, has expended much labour on an exhaustive compilation of statistics on primary and preventive trephining. He tabulates the cases of 196 patients who were trephined for gunshot wound; of these 110 (56 p.c.) died; 46 operations for primary trephining were performed, with a mortality of 32 or 69.6 per cent.

Larrey drew attention to the fact that bullets may remain encysted in the brain for years without producing symptoms. In the surgical history previously mentioned, many cases of recovery—some partial, some complete—after perforation of the brain by bullets and after comminuted fractures with destruction of brain matter, are recorded. In the Franco-German War other similar experiences were met with, and Dr. Gilbert Smith has related the case of a man who recovered from a sabre cut received

in the first Carlist War. The wound was followed by hernia of the brain, and the man was seen alive and well several years after, with a large cavity within the skull, and an opening in the bone. His faculties were unimpaired, as shown by the fact that he was engaged in his business of a painter or photographer.

Longmore[1] has laid down the following rules for treatment of gunshot injuries of the head :—

(1) Trephining, with a view to prevent anticipated consequences of a gunshot injury of the head, and speculative trephining in general, are not justifiable operations. Thus the fact of there being a fracture and the bone being depressed is not of itself a cause for trephining. The occurrence of symptoms of compression, of epileptiform convulsions, or of paralysis shortly after a gunshot wound does not justify the primary use of the trephine when the local condition of injury is concealed from view and uncertain. Local treatment and general remedies should be employed in the first place, and should be persevered in for some days, or even for two or three weeks, unless special urgency arises before trephining is employed.

(2) When there is clear evidence that fragments of bone have been forced down so as to penetrate cerebral substance—not merely that they are or appear to be lying on the dura-mater—and when they cannot be removed by simpler means, the trephine should be used to assist in their extraction as early as possible, whether any symptoms of compression or irritation are or are not present. This applies equally to projectiles or other foreign substances, which may have been forced into the brain substance, and are within reach.

(3) When a patient has sustained a gunshot fracture of the cranium, although the evidence as to the nature of the injury may not be precise, if it may reasonably be inferred that the fracture has been accompanied with depression, or with penetration of the surface of the brain, and the existing symptoms of cerebral compression or irritation, not only do not yield, notwithstanding the continued employment of remedies, but rather show a tendency to become worse, or

[1] Holmes' " System of Surgery," vol. i.

the symptoms become so severe that extinction of life seems to be threatened, trephining is justifiable, under the hope that it may be the means of arresting or removing the source of local mischief, and so averting the threatened fatal consequences.

(4) Lastly, at a later period after gunshot fracture of the cranium, with or without distinct evidence of penetration of the dura-mater, or brain, if after a considerable period of convalescence grave signs of cerebral compression or irritation manifest themselves, and these become more and more intensified in spite of other remedies or treatment, the trephine should be employed in the hope of finding the source of compression or irritation localised, or within reach of relief.

(5) In any case in which trephining is performed, especially in cases where the dura-mater has not been previously exposed by the injury, the operation should be done with strict antiseptic precautions if possible. The relative immunity from irritation, from suppuration, and the more rapid healing of wounds which have been inflicted in opening the cranium under antiseptic precautions, when contrasted with others in which similar treatment has not been adopted, have been demonstrated very conclusively.

It has been proved to be good treatment in bullet wounds of the brain, as in other punctured wounds of the organ, by exploring, cleansing and draining the track, and occasionally it has been found possible to extract the ball through the wound of entrance, or a counter opening in the skull. The future will determine how far it is wise to endeavour to effect the removal of the bullet, and this must largely depend upon previously ascertained extent of liability to the supervention of epilepsy and mental disturbance at a varying period after the lodgment of the missile, that at the time of injury did but comparatively little damage, or at least damage that was spontaneously recovered from.

CHAPTER V.

TREPHINING THE SPINE.

This operation is said to have been originally advocated by Paulus Ægineta, and approved of by Celsus. In the last century it was recommended by Chopart, Desault, and Heister. Louis, in 1774, removed from a patient who had received a gunshot wound of the back, five days after the injury, several loose pieces of bone belonging to the posterior arch of the vertebra, the patient recovering with partial paralysis of the lower extremities. The earliest case on record that I can find is Henry Cline's case, of a man, aged 26, who fell from a second storey and crushed in the spinous processes of three dorsal vertebræ; the cord compressed; extension failed to reduce displacement. On the second day a portion of three dorsal vertebræ resected, a luxation was found which could not be reduced—the man died on the fourth day—with no relief. *Post-mortem* examination revealed the cord torn through. Cline gave the following as reasons which had actuated him to perform this operation, and the principles upon which he looked for success, thus: "In fracture with displacement of the vertebræ which compressed the spinal cord, this great nervous cord was under precisely the same circumstances as the brain, when pressed by fractured skull, and that, therefore, as the elevation of the pressing bone was indicated in the latter case, and often effected with success, so it was equally called for in the former; and that no positive reason could exist why the operation should not be successful, provided the injury of the spinal cord itself were not great, a condition which, as regards the brain, would equally forbid operation, or render its success improbable or impossible."

Jacobson[1] trenchantly combats this. He says, the analogy between the two operations is, for several reasons, a deceptive one, since, owing to the small size of the cord, an injury which would only injure the brain to a slight degree, almost inevitably destroys the structure of the cord throughout its thickness. Again, it must be remembered that a fragment of bone often inflicts injury upon the cord instantaneously and in a moment, and that irrevocable damage may be done, though all deformity may be removed by raising and straightening the patient, and by the elasticity of the bones and by the contraction of the muscles. It has also been shown that the cord itself may be most severely damaged, though its theca shows no sign of injury.

In the skull trephining may be expected to meet with success, when the fracture is the result of direct violence from a small body moving at a high rate of velocity, *e.g.*, a stone or hammer, and the violence has been concentrated upon a limited portion of the skull. But fracture of the spine presents no analogy here. As pointed out before, fracture of the spine is usually due to indirect violence, as when the neck is broken by a fall upon the head, or when the lower dorsal spine is fractured by the fall of a sack upon the shoulders. Even where the fracture is due to direct violence it is of an entirely different nature to that for which the surgeon hopes to trephine successfully in the skull, and one far more likely to produce extensive and crushing damage, *e.g.*, the fall of coal or earth or a fall from a height upon a projecting body.

Again, when the surgeon trephines the skull, he not only hopes that the damage which the brain has received is slight and of a temporary nature, but he also believes that the only damage to the bones is that which lies close to his trephine and finger. But with the spine we are faced with this dilemma: if the fracture has been from direct violence, and the spinous processes and the laminæ have been driven in, it is only too probable that when these are elevated the spinal cord will be found too much damaged to profit by the operation. On the other hand, if the fracture has been caused by indirect violence, it is most certain that the

[1] Holmes' "System of Surgery," vol. i., page 673.

bodies of one or more vertebræ will have been crushed down, and a portion of one of these will be found shot back into the canal. In this case the fragment which has inflicted the injury, and which is keeping up the irritation, will be in front of the cord and out of reach, even if the cord were in a position to be much benefited by its removal. A surgeon trephining the spine under these circumstances, would be like one who trephined the skull in order to remove depressed fragments of the vertex, when all the time a portion of the base of the skull was lying jammed into the under surface of the brain.

It having been shown how misleading is any analogy between the two operations of trephining the skull and spine, it remains to point out that trephining the spine is not only likely to be void of any good results, but that it also involves serious risks, and entails additional dangers of its own.

In fracture of the skull requiring the trephine, the surgeon has to cut through the scalp only in order to reach the depressed fragment. In fracture of the spine, he will be obliged to make a deep incision in the line of the spinous processes, not less than four or five inches long, through skin and muscles, to clear the trough of the spine of its tendons and muscular fibres, and to break up the posterior arches of the vertebræ at the seat of the fracture by means of trephine saws, bone forceps and elevators, when he has forcibly detached the spinous processes and laminæ, and exposed the cord and sheath within the vertebræ situated at a part in front, quite inaccessible.

This formidable operation will have the effect not merely of converting a simple into a compound fracture, but the bottom of the deep ragged wound will be in communication with the interior of the vertebral canal. Hence, if the case follow a common course of compound fractures, and suppuration supervene, the pus that is formed will have free access to the space between the walls of the canal and the sheath of the cord; it may, therefore, penetrate to some distance each way from the seat of fracture, and it is not improbable that, if the operation had been successful in causing the functions of the cord to be restored by the removal of the compressing fragment of bone, these func-

tions would soon be lost again by the inflammation set up in the cord and its membranes, from the presence of the pus around. Furthermore, the gravity of the outlook will be much increased by the opening up of inflamed cancellous tissue, with its venous channels, and the exposure of these to the surrounding suppuration. Many of these risks may, I readily admit, be lessened by the use of antiseptic precautions, when the surgeon has facilities for using them ready to his hand; but the above are not the only risks entailed by trephining the spine.

Let it be considered what the effect of dividing will be, in the course of operation, the muscles and their tendons that may be in the way, and of removing portions of the posterior segments of the vertebra at the seat of fracture. These are the principal structures by which the broken ends of the upper and lower fragments of the spine are held together; consequently, when they are cut and taken away, the mobility of the fractured part will be greatly increased. When any attempts, therefore, are made, with the view of defending the hips from bedsores, to vary the position of the patient by turning him round in bed, the fragments will roll freely on each other; there will be a grating of their surfaces, the attempts will be unsuccessful, and the cord will be inevitably injured.

Up to 1867, I find thirty cases recorded, with three relieved; the rest died. Since this date, Macewen has recorded six cases in which elevation of the posterior laminæ of the vertebræ has been performed; four completely recovered, and two died. Thornburn, a case for compression with no satisfactory result. Victor Horsley has trephined the spine (1890) nineteen times, with one death, in six of the cases opening the theca, with a death-rate of, say, 5 per cent.; he considers, unquestionably, that we ought to operate without delay in all cases where displacement or crepitus denotes compression, and where extension, directly after the accident, clearly fails to reduce the deformity. In caries of the spine, where there is great pain and the case chronic, the operation may give great relief, and should be done.

Fracture of the spine is almost always followed by death; and, as the bad consequences of the fracture may be depen-

dent on the primary lesion of the cord, but also on the secondary inflammatory processes caused by the irritation of the fractured fragments of bone, we are justified by operation to attempt to remove this certain source of impending death.

Vincent (*Rev. de Chir.*, February, 1892) reports three cases in which he trephined the spine for penetrating gunshot wounds with injury to spine. In the first case, which was one of injury to the first lumbar vertebra, removal of fragments of bone, and of the bullet from the spinal canal, was followed by complete recovery. In the other two cases —each of penetrating wound in the lower part of the dorsal region, with laceration of the cord and its membranes— similar treatment was followed by death, in one on the eleventh, in the other on the ninety-fourth day. With these are tabulated thirty other cases collected from various sources. Of the thirty-three cases, eight were treated by surgical intervention, with three recoveries and three deaths. Of the twenty-five patients treated without operation, five recovered and twenty succumbed. Vincent comes to the following conclusions: (1) These injuries, although very grave, are not inevitably fatal, and some of the injured subjects, there is reason to believe, may be saved by surgical intervention. (2) Whatever be the nature of the injury to the cord—unless it be complicated by serious injury to abdominal or thoracic viscera, and provided the gunshot wound has involved the posterior or lateral parts of the spine at an accessible region—the surgeon should open up the track of the bullet as far as the vertebral arch, and after investigation of the nature and extent of the lesion, extract any foreign bodies likely to compress and irritate the cord. If it be found necessary to trephine the walls of the spinal canal, he should not hesitate to do so. Such treatment may be found beneficial, and, though sometimes useless, will never do any harm if practised under strict antiseptic conditions.

CHAPTER VI.

REMARKS ON TREPHINING.

A well-known writer on the subject of Brain Surgery [1] heads a paper with these words:—"I watched a patient die after a fracture of the cranium, and found at the autopsy, immediately under the fracture, a cerebral abscess, from the surface of which was extracted a piece of bone driven in at the time of injury. I had seen the vigorous man admitted; seen him first intelligent, scarcely sick, perhaps, then confused and delirious, then comatose, and finally dead. As the elements of this human life were being successively extinguished by increasing destruction of nerve centres, the routine and approved medicinal treatment for encephalitis was steadily continued. It took little surgical experience to recognize the lamentable result of the inactive so-called conservative treatment, which almost to a certainty sacrificed this patient's life." And yet how few house surgeons of hospitals, twenty years ago, yea, less, who do not remember similar cases—I can easily recall two.

In every case of severe head injury, the surgeon is face to face with the momentous question—can I by any operation save my patient's life? During the last twenty years a reaction has apparently set in in favour of trephining. [2] Following upon the reckless use of the trephine during the sixteenth and seventeenth centuries, the operation gradually fell into disrepute and notwithstanding the strong advocacy which it received in later times from the writings of Pott,

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[1] Roberts, of Philadelphia. [2] Walsham.

and also from the Royal Academy of Surgery in France, had almost ceased to be practised. Among the chief opponents were Desault and Malgaigne who maintained that the operation was absolutely useless and ought to be altogether abandoned.

These doctrines, although combated by Boyer, Dupuytren, Roux, Velpeau and Chassaignac obtained such a hold upon French surgery that M. Le Fort, writing in 1867, stated that within the preceding ten years the operation had only been performed four times in France. But that the operation had also lost ground in this country is evident from the statement of Mr. Callender (*St. Bart's. Hospital Reports*, 1867) that there had been no cases of trephining for over six years in the wards of St. Bartholomew's. There is now, perhaps, some risk of our passing into an opposite extreme. M. Sedillot has contributed a paper "On the Expediency of Returning to the Doctrine of Hippocrates that all Fractures of the Vault ought to be Trephined." He advocated the operation not only as a curative measure but also as a means of diagnosis in doubtful cases of fracture of the internal table. M. Lucas Championnière recommends it in certain forms of motor paralysis, unattended by either scalp wound or fracture of the skull, whilst Echeverria and others have again revived its use in traumatic epilepsy. Notwithstanding the general reaction in favour of the operation, there are still many who altogether condemn it; and even among the majority who hold it to be justifiable, and ought imperatively to be undertaken in suitable cases, opinion differs very widely as to what cases should be considered suitable. Whilst some would confine its use within very narrow limits, others, like Sedillot, would employ it still more extensively than did the older surgeons. This difference of opinion seems in great part to depend upon the view that the individual surgeon holds of the danger of the operation of trephining. In certain cases, as in punctured fracture of the vault, where fragments cannot be otherwise removed, and in cases where unequivocal signs of pus or blood between the bone and dura-mater are present, all, save an uncompromising few, would without hesitation recommend it. But in considering the propriety of trephining in cases

where an element of doubt exists, either as to the nature of the lesion or the benefit that might accrue from surgical intervention, the surgeon's opinion is undoubtedly much biassed, according as he regards the operation in itself as attended with extreme, moderate, or but slight danger.

It has been well said that statistics can be made to prove anything, and therefore we must take them for what they are worth. Foreign statistics give an average mortality of 56 per cent., but in many of these cases death has been due to injuries other than those of the head, such as rupture of the renal vein of the liver, &c., and therefore we may conclude that they are fallacious. Coming to our own country and going back thirty years, I find at Guy's Hospital, from 1861 to 1868 (seven years) 51 operations in which the trephine and elevator were used, and 39 deaths, or a mortality of 76.5 per cent. From 1871 to 1876 (five years) they had 16 operations with 12 deaths. At St. Thomas' Hospital, from 1866 to 1870 (four years) they had 3 operations and all died. At St. George's Hospital, from 1870 to 1877, they had 16 operations with 13 deaths. At University Hospital, Erichsen gives 6 cases of recovery out of 17. Walsham, in 1882, collected 686 cases with 417 recoveries and 269 deaths, a mortality of 39.3 per cent. Dr. R. W. Amidon, of New York, has collected 115 cases of trephining and kindred operations occurring since 1879. These operations were done for various causes and were unselected, nor were they confined to cases treated antiseptically. Of these 115 unselected cases 29 died; but of these 25 presented, at the time of operation, symptoms endangering life, leaving, therefore, but four cases in which the fatal issue could be attributed to the operation. This gives a mortality of a little over 3 per cent. to the operation.

The statistics of H. R. Wharton concerning foreign bodies lodged in the brain show the importance of removal when possible. Of 106 cases in which removal was accomplished, only 34 died; of 210 cases in which no attempt at removal was made, 122 died.

Dr. Roswell Park (*Medical Record*, September, 1888) collected reports of 63 cases, of which 17 terminated fatally, although only five of these deaths could properly

be attributed to the operation; 15 of the cases were abscesses, subdural or subcortical. In 11 cases the lesion was a tumour exclusive of tubercular nodules. Of cysts, properly speaking, there were 12. The 25 other cases were of a miscellaneous nature. In three cases the true character of the lesion was not revealed during the operation, and was only discovered at the autopsy. In 2 cases in which no palpable or visible lesion was discovered at the time of operating, the symptoms which led to the performance of the operation were nevertheless relieved, although nothing but careful exploration was practised.

The introduction of antiseptic surgery has greatly reduced the mortality. Kramer gives the following result of published cases with antiseptic precautions: Of 25 cases in which primary trephining was done for compound fracture, 21 healed by first intention, 2 after suppuration and 2 died, 1 of circumscribed meningitis, and 1 of meningo-encephalitis. In 6 cases of secondary trephining, 3 healed by first intention, 2 by second intention, and 1 died with hernia cerebri. In 22 cases in which the skull was opened through a previously sound scalp, for tumours, epilepsy, old depressed fractures, &c., 21 healed without fever, 13 by first intention, and none died.

Horsley has broken the record by 10 operations and one death up to the end of 1886, in nine of which he removed considerable portions of brain, and these all recovered. The fatal case was a tubercular patient in feeble health, and never recovered from the shock of the operation upon the cerebellum.

Great tolerance of the brain to incision is well known amongst the lower animals; they bear without serious risk to life ablation of large areas of brain substance. I have exemplified this in infants after craniotomy; when the cranium has been almost totally emptied of brain matter, the child has lived for thirty minutes. We have looked upon the human brain and its membranes very much as, until recently, we looked upon the heart and pericardium—a region never to be approached with trocar or scalpel. Many patients have died of brain abscess or tumour because the timidity of the surgeon prevented the introduction of an aspirating needle or knife to open the pus cavity,

or the employment of enucleation for the detachment of a neoplastic growth.

We may ask—when should we use the trephine? As early as possible, as we wish to anticipate the secondary inflammatory result which will show itself from irritation of sharp fragments of bone. It is never too late to trephine; successful cases have been reported where the patient was comatose and many cases of abscess of the brain caused by pressure have recovered after the use of the instrument. "It is in accord with sound surgical principles to expect that preventive trephining should succeed, since by removing sources of irritation we may prevent intra-cranial mischief. The history of the case will often help greatly to form a sound judgment for its indication."

Drainage is more essential, according to Roberts, than in wounds of other structures. He says it would seem to be a self-evident proposition that drainage is as essential in wounds of the brain, as in wounds of other structures, and yet gunshot and other wounds of the skull and of the cerebral membranes and hemispheres have long been treated as if drainage was not a necessary factor in therapeutics. A surgeon who would think himself censurable to leave the opening leading into a suppurating cavity obstructed by shreds of skin and fascia, will, with profound equanimity, see his patient die with pus burrowing among the vital centres of the brain. There may be but a small fissure or opening or perhaps none at all in the bony wall enclosing the brain, and but a mere puncture in the tense dura-mater, yet he will hesitate to give free exit to the pus. We split open a knee-joint, we incise a pleural, peritoneal or pericardial cavity to give free egress to pus, so must we cut away the cranium and incise the dura-mater in analagous conditions. The greatest error in this connection has perhaps been in an expectant instead of an operative treatment, fearing that "striving to better, oft we mar what's well."

Lately, Mr. Walsham has been trying the method of the replantation of the fragments of the bone removed by the operation and accurately closing the wound without drainage. It offers a great contrast, as regards treatment, to the method of procedure which is usually practised for these

injuries, and, of course, the cases in which it may be tried are limited and will usually be those of children. He orders the scalp to be shaved for five inches round the wound, washed, and scrubbed with soap and water and a stiff brush, all grease removed with turpentine, again washed with water, and finally with perchloride of mercury (1-2000). The wound itself is then carefully cleansed, all hair that had escaped in shaving the scalp removed, and ragged and dirt-ingrained portions of tissue carefully excised. The wound is then prolonged, a flap of the scalp turned up and protected, and the depressed fragments trephined and removed. These are placed in hot perchloride solution (1-4000). The fragments of bone are next replaced with their smooth surfaces towards the dura-mater and the flaps brought accurately together with silk sutures—no drain employed; the wound dressed with moist sal alembroth gauze and wool, and firm pressure applied over the whole vault of the skull.

In the six cases so treated, union by first intention has practically been the result. The elaborate toilet and the completely cut away edges of the flaps are the important points to ensure immediate union, and so render the wound subcutaneous as soon as possible.

The question naturally recurs to me, may not the high death-rate of the earlier cases be due, in a great measure, to the septic atmosphere with which hospital surgeons at these dates had to deal? And in proof of this, I find that in Cornwall, Pott's principles still prevail. An eminent surgeon there says: "Their utility has been illustrated in numerous cases. A very large percentage of the cases recover. If death ensue there are generally obvious causes to account for it, such as diffused injury, with laceration of brain substance, of fractured base, that success seems mainly to depend on an early operation, as soon after the accident as convenient, and that we place the operation in the same category as herniotomy, viz., harmless in itself if skilfully performed, but in most cases useless if delayed until the appearance of symptoms.

Too much stress cannot be laid on one circumstance which tells greatly in our favour—I refer to the purity of the atmosphere — when we contrast our results with those

given in our large hospitals; but if the antiseptic system be carried out in the spirit of the apostle, may we not in pyæmic atmospheres resort to the principles maintained with such energy by Pott, and avert the fatal mischief which supervenes from inflammation and suppuration between the dura-mater and bone.

The introduction of antiseptic surgery has rendered trephining a far less formidable operation than it used to be, and, therefore, we should be less shy in resorting to it; at the same time we must have good reason for resorting to it, and not to appear to trephine for trephining's sake.

Professor Yeo[1] (of King's College) says, "The use of the trephine has been gradually falling into discredit since the beginning of the century, because the admission of air into the cranial cavity proved to be nearly as fatal as the irritation which the operation sought to remove.

"As our knowledge of the important part played by septic agencies in exciting inflammation increases, and our power of excluding from wounds becomes more perfect, there is every reason to hope that operations on the cranium may be stripped of their terror, and its serous cavity opened with impunity. The greater insight given to intra-cranial affections, by the localisation of cerebral functions, seem to suggest that surgical aid may be sought in many cases which have hitherto been looked upon as quite beyond its reach. Thus M. Broca was able to localise the situation of an abscess of the brain, and gave exit to pus. Again, M. Lucas Championnière, in his work, shows how cerebral localisation may help cranial surgery. Dr. Yeo operated by trephine on monkeys treated in the same manner as human subjects; in 26 cases by Lister's method, seven cases died; of these four died from causes not dependent on operation or dressing. Of the remaining three fatal cases, one was caused by hæmorrhage six days after the operation, another died of shock, and one only from inflammation."

Professor Nancrede lays great stress upon thorough cleansing of compound depressed fractures. He recommends shaving the scalp, scrubbing with soap and water,

[1] *British Medical Journal*, 1881, vol. i. "A note on the application of the Antiseptic Method of Dressing Cranio-cerebral Surgery."

sponging with turpentine or ether, and completing the disinfecting toilet with mercuric bichloride solution. In support of the belief that trephining is not a dangerous operation, and that more die from complications which might have been prevented by timely interference than from the removal of a disc of bone, shows that the old mortality of trephining *per se*, which he puts at 10.69, is now with antiseptic precautions reduced to 1.6 per cent.

A point of considerable interest is, the cause of more extensive splintering of one than the other table in certain fractures of the skull.

In accordance with the well-known mechanical law, that compressing force applied to the outside of a surface tends to produce more extensive breaking of the inner surface, and hence it has long been observed that in depressed and punctured fractures of the skull, one table, ordinarily the inner, is more extensively splintered than the other. In 32 cases reported, it is specially mentioned in 9 of them. To account for this occurrence many experiments have been made and various theories brought forward.

In fractures of the skull the breaking force is always applied to the outside, and rarely also to the inside, and because the more extensive splintering is just as often in the inner, and as rarely in the outer table, therefore peculiar conditions have been sought for, in the inner, to account for it.

When it was believed that this kind of splintering only took place in the inner table, it was said to be due to that plate of bone being more brittle than the outer. It is now, however, known to take place in both. It has been accounted for by stating that the force is transmitted to a wider area, as the body causing the fracture passes into or through the bone, carrying its substance before it. This theory, while partially explaining its presence in the case of blunt fracturing bodies, fails entirely, as Mr. Erichsen has shown, when the body causing the fracture is sharp like a nail. Again, by Mr. Erichsen, it is considered to be due to the direction of the fracturing force, and the loss of the momentum in the breaking body, and he quotes a case to prove that the more extensive splintering occurs in the table last affected by the fracturing force. There is also no

doubt that the loss of momentum in the breaking body increases the splintering, whilst again the inner table forms a smaller curve than the outer one.

Dr. Kirker, in explaining the fact that in some cases of depressed and punctured fractures of the skull, including all those occurring during life, there is markedly more extensive splintering of one table than the other, while in others it exists to only a slight degree, and even may not take place at all. He answers :—The comparative want of support in the former, of the table last affected by the fracturing force, and its presence to a greater degree in the latter. Take a homely example :—When a nail is driven through two boards, there is splintering of the wood, when the point of the nail emerges from the second, but none when it emerges from the first. Who has not seen a carpenter when about to make an auger-hole in a planed board, attach a piece of wood to its under surface, to prevent the auger making splinters at the lower end of the hole? Although in these fractures of the skull the unequal splintering of the tables is due to the fracturing force first attacking the table, supported by the other and the intervening diploë, and afterwards that, without any firm support, it varies under certain circumstances.

(1) When the breaking body is blunt, it carries the bone before it, and affects a larger area of the second than the first table.

(2) The greater the momentum of the breaking body, the less the splintering, but it is possible that its influence is in the opposite direction. In brittle substances the connexions between the component particles are readily broken, and when such a substance is acted on by a breaking body, the particles affected have a greater tendency to sever their connexions with neighbouring ones, than communicate to them the fracturing force.

A depressed fracture is usually recognised, especially if compound; the depression may involve one or both tables; if the outer table be alone affected, we shall find the depression exceedingly slight, as it can only be depressed to the extent of the diploë. When the force is not severe, only the inner layer of bone is sometimes affected.

When the force acts from within the cranium — the

external plate gives way first, and is more extensively fractured than the inner table. This is seen when bullets, after entering the skull at one point, strike on their outward course the inner table at another.

With regard to the replacement of bone after trephining, Dr. Weir[1] relates some particulars of a patient suffering from traumatic epilepsy, and on whom he had operated. At the first operation trephining was performed over the frontal region, where there was a marked bony depression, and the inner table was found driven in angularly, great improvement followed; later the fits returned, with a condition of mania with severe pain over the forehead; three trephine holes were made and the opening further enlarged with bone forceps. Some pus was found in the frontal sinus, but the brain and membranes were healthy. The three discs of bone were returned, having been kept in a warm antiseptic cloth, and the interstices filled up as far as possible with the chips. Everything healed up without any trouble, and the fits were reduced in number. The patient recently returned to hospital on account of a burn, and thus afforded an opportunity of seeing the result of the replacement of bone four years previously. It was found that the whole bony surface was somewhat sunken, but no irregularities could be felt. At one point in the depressed bone a slight pulsation was visible, due probably to a partial absorption of the bone. In another case, in which he removed a sarcoma from the brain, afterwards replacing the bone which formed a firm solid plug, recurrence of the growth took place, and about two years and a-half after the original operation, pulsation appeared over the trephine opening, the re-implanted bone was pushed up, and gradually disappeared entirely. The fate of such pieces of bone is a very important point in cerebral surgery.

It must not be forgotten that the bone is frequently of unequal thickness at various parts of the circumference of a trephine opening. It is unadvisable to apply the trephine over the course of sutures if it can be avoided, because at these points the dura-mater is usually adherent, and the bone varies much in thickness. Is is also undesirable to

[1] *New York Medical Journal*, 1891.

trephine over the anterior inferior parietal angle, for fear of wounding the middle meningeal artery, nor over the frontal sinus from the supposed fear of an aërial fistula. The skull cap may be found to vary in thickness from one-fifth of an inch in some places to three-fourths in others. In aged people the bone may often be found thinned by absorption. Holden's advice is classical:—"Think you are operating on the thinnest skull ever seen, and thinner in one portion of the circle than another." Dr. P. H. Watson has suggested that where the use of the centre pin is undesirable, the trephine should be steadied by applying it through a perforated piece of pasteboard, firmly held against the bone.

Age is no bar against the operation; a child twelve months old has been successfully trephined for a punctured fracture of the skull, and many cases have been operated upon in old age.

The trephine opening is usually closed by fibrous tissue, occasionally by fibro-cartilage, and rarely by the thin plate of bone. Sometimes the bony margins thicken, at other times they will be found thinner.

The State of the Eyes.—In compound and depressed fractures the pupils are generally normal, in four cases out of thirty-two they were noted as dilated, in three contracted, but I have met with only one case in which they were unequal.

In cases of hæmorrhage from the middle meningeal artery, dilatation of the pupil on the side of the hæmorrhage and opposite to the side paralysed, we have a symptom which may be of much value in diagnosis. It has been called Hutchinson's pupil, because Mr. J. Hutchinson was the first to call attention to this condition as a special symptom. This dilatation is said to be caused by supposed gravitation and extension of the blood clot, which exists between the bone and the dura-mater, to the base of the skull so as to interfere with the function of the third nerve by pressure upon it. Where we find the pupils natural as regards reaction to light, the compression is probably recoverable, as we probably have to deal with only compression of brain which may be relieved by trephining. Again, if the pupils are insensitive, often at the same time dilated, the compression is probably extreme, and therefore if trephining is

done, it is very uncertain if the brain will recover itself after removal of the clot.

Dilatation of the pupils is probably an indication or expression of sensory irritation. It is well known that sudden or painful stimulation of sensory nerves is associated with dilatation of the pupils; this re-action is produced through the medium of the sympathetic nerves, which act on the dilating fibres of the iris. We may ask, has recent research in ophthalmic medicine done anything to help us to a diagnosis?

We have papillary stasis as a result of injury to the brain, it may or may not be accompanied by disorder of vision; unfortunately this papillary stasis, as far as I know, cannot be considered as yet belonging more particularly to one lesion of the brain than another, neither is it a criterion of the gravity of the lesion; perhaps all we can assert at present is that it indicates the presence of fluid or pressure on the meninges. In one case examined by ophthalmoscope on the sixth day after fracture of skull, it was noted that the veins were remarkably tortuous, a peculiar haze seemed to exist over all parts of the vessels, but all parts of the disc could be seen. The disc and vessels on it had a peculiar glistening, whitish, streaky appearance. There was a well-marked physiological cup extending to the outer side. In a case seen by Dr. Gowers (fracture with compression) during a severe fit, the left eye remained open whilst the right was closed, Dr. Gowers was able to watch a retinal artery and vein by the direct method of observation, from the very commencement to the end of the fit. Not the slightest diminution of their calibre could be observed. When respiration was arrested and the face became dusky, the veins appeared distended and darker, no other change was observed. It is to be remarked, in connection with this absence of spasm of the retinal vessels, that pallor of the face was likewise absent. Very little knowledge has been acquired as yet, but it opens out a field for research.

The almost constant appearance of optic neuritis in cases of cerebral and cerebellar tumours has often been noticed. It appears to be independent of the position of the tumour; it is almost invariably double, but occasionally one eye alone has been affected, viz., that on the side of the lesion, or one has been much more affected than the other.

In a study of forty-six cases; aphasia is noted as having occurred in three of them. "In this remarkable, and in a physio-psychological sense, highly instructive condition, the subject is deprived of the faculty of articulate speech, and also very generally of the faculty of expressing his thoughts in writing, while he continues intelligently to comprehend the meaning of words spoken to him, or, it may be, to appreciate the meaning of written language. An aphasic individual knows perfectly well, as exhibited by his gestures, if a thing is called by its right name or not, but he cannot utter the word himself, or write it when suggested to him. In his attempts, only an automatic or interjectional expression, or some unintelligible jargon escapes his lips, or unmeaning scrawls are set down on paper as writing. This affection is usually, at first at least, associated with a greater or less degree of right hemiplegia, but the motor affection of the right side, chiefly of the right arm, is often slight and transient, or may be wanting from the first, the only indication of motor paralysis being a paresic or weak condition of the oral muscles of the right side. Broca shows the cause of this affection to be associated with disease in the region of the posterior extremity of the third left frontal convolution, where it abuts on the fissure of Sylvius, and overlaps the island of Reil.

Probably one of the most common causes of aphasia is softening in this region, consequent on sudden stoppage of the circulation by embolic plugging of the arterial channels which convey its blood supply, by which the functional activity of the part is temporarily or permanently suspended, owing to the proximity and common vascular supply of the motor centre of the hand and facial muscles; it is easy to see how they also become implicated in the lesion of the centres of articulation, and why, therefore, dextral and facial motor paralysis should so commonly occur along with aphasia.

I take it that a person aphasic from destruction of his speech centre still remains capable of appreciating the meaning of words said in his hearing. His centres of sight, hearing, &c., being unimpaired, he is as capable as before of using these senses. The difference consists in the fact

that in the aphasic, the word spoken, though it calls up the idea or meaning, cannot call up the word itself actually or in idea, owing to the centres of word execution and word ideation being destroyed.

The speech centre is in the great majority of cases situated in the left hemisphere, but there is no reason, beyond education and heredity, why this should be so.

It is quite conceivable that the articulating centres of the right hemisphere should be educated in a similar manner. A person who has lost the use of the right hand may by education and practice acquire with the left all the cunning of his right. In such a case the manual motor centres of the right hemisphere become the centre of motor acquisitions similar to those of the left. As regards the articulating centres, the rule seems to be that they are educated, and become the organic seat of volitional acquisitions on the same side as the manual centres. Hence as most people are right-handed the education of the centres of volitional movements takes place in the left hemisphere; this is borne out in a striking manner by the occurrence of cases of aphasia with left hemiplegia in left-handed people. (Case recorded in *British Medical Journal*, October 24, 1874.) The rapid recovery which so frequently occurs in cases of aphasia, especially of the kind due to embolic plugging of the nutrient arteries of the left centres, is not so much to be regarded as an indication of the education of the right centres, but rather of the re-establishment of the circulation and nutrition in parts only temporarily rendered functionless."

Paralysis of the face occurred in three cases, and in each was most marked on the same side as the injury. Paralysis of the extremities occurred in nine cases, and in every case on the opposite side to the injury. Bilateral destruction of the antero-frontal region causes neither motor nor sensory paralysis.

Dr. Brown-Sequard advanced some remarkable views (*Lancet*, January, 1876). He thought the cross action of the cerebral hemisphere is an untenable doctrine, and regards each hemisphere as sufficient for the innervation of both sides of the body. The paralysis from brain diseases he attributes not, as is usually held, to loss of function in the part diseased, but to an inhibitory influence on centres

of motion, excited by irritation starting from the seat of the disease or its neighbourhood.

The recorded cases go to prove the fallacy of his views, and we can only admit, then, that there may be exceptions, just as there are exceptions to the rule that the heart is situated to the left, and the liver to the right. To go beyond this is simply to stultify every well-established rule in the clinical diagnosis of brain lesions—rules which are not the product of preconceived notions, but founded on the irrefragable evidence of unquestioned facts. At this time attention was attracted by the remarkable works of Hitzig and Ferrier, on cerebral localisation; they proved by their investigations that there exist certain zones on the surface of the brain, in the fronto-parietal region, which, if irritated, will give rise to convulsions or contractions in the opposite half of the body. If these zones are removed or destroyed, paralysis of certain members follows. According to M. Vulpian, these zones act through the intermediary agency of the grey cortical matter, or through the white matter which is situated beneath the grey substance. Rochefontaine and Duret have shown that a certain proportion of the phenomena of irritation, such as convulsions and contractions, can be traced back to lesions of the nerves of the meninges, especially of the dura-mater. These phenomena ought in fact to be regarded as true reflex actions, of which we know the centripetal tract, the centre, and the centrifugal tract. Having once settled the different centres of localisation in the brain, the next step was to discover what particular spot on the skull would correspond to the said centres. This could best be done by ascertaining the position of the fissure of Rolando, seeing that such of the motor centres whose position is sufficiently well known, are situated around it.

This chapter will not be complete if some reference is not made to the *diagnosis* of cerebral disease—for this *resumé* I am indebted to Dr. Starr's work on Brain Surgery—"There are certain areas upon the cortex not necessarily co-extensive with either lobes or convolutions, whose functions are accurately known. These areas are (1) the sensori-motor area, (2) the speech areas, (3) the visual area, (4) the auditory area, (5) the area of sensations of smell and taste.

"1. *The sensori-motor area* includes the cortex of the anterior and posterior central convolutions which border the fissure of Rolando and the adjacent cortex in front and behind these convolutions. Each hemisphere controls movement on the opposite side of the body, but as the right hand is more generally used and is better trained than the left, this area is larger on the left hemisphere than on the right. The cortex of the posterior part of the second frontal convolution controls the movements of the eyes and head. Impulses starting from this area produce conjugate movement of these parts towards the opposite side. The eye district is below, the head district above.

"The lower third of the anterior and posterior central convolutions governs the movements of the face, tongue, larynx and pharynx. The eyebrows and cheeks are controlled by the upper and forward part of this area; the tongue and larynx by the lower and forward part, the mouth, pharynx and platysma by the hinder part.

"The middle third of the anterior and posterior central convolutions governs the movements of the upper extremity —the shoulder motions being controlled in the anterior and upper part of this area, the elbow motions in its middle part, the hands and finger motions in its posterior and lower part.

"The upper third of the anterior and posterior central convolutions including their junction in the para-central lobe controls the motions of the lower extremity; the thigh, knee, foot and toes being governed by various parts of this area from before backward in the order named.

"It will be noticed that the parts susceptible of the finest and most delicate movements, those directed by the most acute sensations, the lips, the fingers and toes, lie furthest back in the motor area, chiefly in the posterior central convolutions. Lesions in this convolution almost always cause some loss of tactile sensation as well as paralysis, and hence this area is thought to be the seat of tactile sensations as well as of movements, while some cases point to the localization of muscular sensations in the area just behind that of motion.

"2. *The speech areas* are of four kinds and in four locations; and limited to the left hemisphere in right-handed

persons and to the right hemisphere in left-handed persons. There is *the motor speech area* in the posterior part of the third frontal convolution, in which the movements concerned in the act of speaking are controlled. The use of language and the power of talking are affected when this region is destroyed. There is *the auditory speech area* in the first and second temporal convolutions in which the memories of word-sounds are stored up. The understanding of language and the power of recollecting the names of objects are lost when this region is destroyed. There is *the visual speech area* in the lower parietal region in which the memories of printed words are stored up. The understanding of written language and the power to read are lost when this region is destroyed. *The power of writing* is a part of speech and is usually lost when the motor speech area is destroyed.

"3. *The area of sensations of sight* is located in the occipital lobe of the brain. Each occipital lobe receives impressions from one half of both eyes, hence a lesion in one lobe produces hemianopia, a half blindness in both eyes, the blind field of vision being on the opposite side to the lesion.

"4. *The area of sensations of sound* is located in the first and second temporal convolutions of the brain; each ear is connected with both hemispheres, hence deafness from a unilateral is partial and not generally noticed, but if both temporal lobes are destroyed, the patient becomes totally deaf.

"5. *The area of sensations of smell and taste* is located at the tip of the temporal lobe on its under and inner surface, which rests on the sphenoid bone; each lobe is related to sensory organs on both sides, and a unilateral lesion does not often produce noticeable symptoms. There are large areas of the cortex of the brain whose function is undetermined, these are much more extensive on the right hemisphere than on the left. There are no definite symptoms produced, so far as we now know, by lesions in these areas, but the negative fact is certain that lesions in them do not cause disturbance of motion, of sensation or of speech (this was well shown in the case reported on page 57, the little fellow on admission showing no signs of brain injury and chatting quite pleasantly to bystanders). For the co-

ordination of facts into orderly series for comparison and for analysis of knowledge gained through the senses the healthy state of the frontal lobes appear to be necessary; and lesions in the frontal region, especially on the left side, are quite uniformly attended by mental dulness, apathy, lack of power or concentration and imperfect self-control. The cortex of the hemispheres upon the base of the brain has as yet no assignable functions and lesions in these regions do not produce recognisable symptoms."

I find from a collection I have made, that out of 32 cases 6 were cases of punctured fracture, 23 compound depressed, and 3 simple depressed fractures. Of these 11 were on the right side of the head, 17 on the left side, one in the middle, and 3 location not stated. Hernia cerebri occurred in 6 of the cases. By appropriate treatment every case was cured. Convulsions without paralysis occurred in 3 of the cases.

Brodie's opinion, that recovery is more apt to follow wounds of the anterior portion of the brain, is confirmed by an examination of Dr. Wharton's (Philadelphia) cases, wherein he gives an analysis of 316 recorded cases in which foreign bodies were lodged in the brain (of these 160 recovered, 156 died); where the foreign body penetrated the frontal bone, 132 in number, 58 ended fatally, and 74 ended in recovery. The parietal bone was penetrated 58 times, with 27 deaths and 31 recoveries. The occipital bone received the lesion in 23 cases; 16 of the subjects died and 7 recovered. The foreign body entered the brain through the temporal bone 31 times; there were 12 deaths and 19 recoveries. Wounds of the orbits were by far the most fatal; there were 18 cases on record, all but 1 of which resulted fatally. My limited experience rather disagrees with Brodie's opinion. I have notes of 3 cases of fracture of the skull in the occipital region with depression which were treated by the expectant plan, and all recovered.

With all the light of past experience, and with all the recorded results of the practice of the great men of past years for our instruction, the propriety of immediate operation in cases of depressed fracture is still an undecided point of surgery. All authorities agree that, when symptoms of brain pressure arise as a consequence of such

injuries, or where inflammatory symptoms develop themselves, not speedily yielding to antiphlogistic treatment, our duty is then to operate by trephining, so as to give exit to pus or remove a source of otherwise fatal irritation; but it seems to me that the important, and yet undecided question is, are we to use these means *at first*, without waiting for the development of symptoms, in order to prevent their occurrence?

I think it is not improbable that in the operative treatment of injuries and diseases of the skull, some of the most important advances in the immediate future of surgery will be made. We now operate on deformed bones, freely open the knee-joint, and undertake operations on the abdominal viscera, which but a few years ago were looked upon as beyond the bounds of practical surgery, and the therapeutic advances that have made these procedures so successful may, I think, be equally well applied to the surgery of the head.

An essential condition of successful treatment is accuracy in diagnosis, and as recent discoveries of the special function of individual portions of the surface of the brain are rendering exact diagnosis of superficial brain lesions possible, I have little doubt that surgery will keepup with the science of diagnosis.

Latterly some inclination to extend the use of the trephine has shown itself, for the reason that the operation, when properly conducted (especially when carried out with antiseptic precautions), is not a very dangerous one, and if I may argue from Dr. Yeo's experiments on monkeys to man, to which I have previously alluded, we may say that the use of the trephine adds very little to the gravity of the case. One cause of non-success of trephining, I believe, is its being delayed too long; pressure on the brain for a few hours is productive of far more mischief than an early operation is likely to cause, besides, the patient is better able for it early than late.

Hilton[1] says, "If a portion of bone be pressed in upon the skull you have only to remove it and give the brain rest, and the brain will repair itself. It is not the operation

[1] "Rest and Pain," p. 65.

that cures the injury to the organ, but by removing the disturbing cause the brain recovers itself."

Again, from time to time *post-mortem* examinations reveal the fact that a life might often be saved by the timely use of the trephine.

"To tap the recesses of the brain and wrestle with disease in the innermost stronghold of life, to determine with unerring accuracy the precise convolution or a part of a convolution over which to operate, as well as its exact position beneath the scalp and cranium, is to achieve a triumph over the forces of disease which seems incredible to the uninitiated," and yet the last ten years have seen this accomplished. Brain surgery is the practical outcome of many years of scientific research, and it is a triumph of clinical observation and experimental physiology, even greater than that of surgery. The fruits of investigation ripen slowly, discovery germinates discovery, and sooner or later, but usually later, humanity reaps the benefit.

In 1861 Broca discovered in the small convolution that bears his name the function of articulate speech; this subverted a once infallible dogma of brain physiology, viz., that the cerebrum performs its functions as a whole. In 1869 Hughlings Jackson affirmed that the brain is endowed with separate and distinct functions, presided over by specific convolutions, and these views gave an impetus to the study of brain pathology, and which paved the way to the question of cerebral surgery. Two difficulties still blocked the way—the surgical after-risks and the absence of infallible guides to the site of operations. These have been removed by the introduction of antiseptic surgery and the investigation of the relations of internal and external parts. Surgery now interposes where it formerly held aloof, and looking back on the marvellous results of recent years, the limit of its power seems to be still far off. And may we not now say in the words of the immortal bard in "Macbeth,"

> "The times have been, that
> When the brains were out
> The man would die, and
> There an end, but now they rise again."

There appears to me, after what I have read and written, to be no sufficient ground for formulating the rules of

practice otherwise than at present laid down by our best authorities, but it may be more liberally interpreted. Close watch for symptoms of local mischief, be they motor, sensory, psychic, should be kept up, and the trephine resorted to as soon as any such symptoms show themselves, even though slight, and with strong hopes of a successful issue; instead of as at present, looking upon it as a *dernier ressort*, and using it timidly and with gloomy foreboding. The surgeon fails in his duty to his patient when the case is going from bad to worse, not to offer him a last chance, which in many cases has been successful.

I cannot conclude better, to my mind, than in the words of a living surgeon to his class; "Let the surgeon have an unbounded faith in the restorative power of natural processes, and let him accept cheerfully and gratefully a humble position as Nature's handmaid. Let him do what Nature unassisted cannot do, replace displaced parts, let him remove all hindrance from natural repair, let him then *leave the case alone*, guarding it with a watchful eye, ever open to suggest the removal of what may interfere with natural repair, or the application of what may prove a help towards the attainment of the desired end, he will then understand in all its fulness, the *evil of meddlesome practice of meddlesome surgery*. The surgeon should, before he interferes, to use a legal phrase, show cause why he should do so. For if he be not sure that he can do no good, let him be sure that he does no evil. Cases will be encountered so obscure and unpronounced as to baffle the keenest analysis. Whenever, therefore, the surgeon is compelled to proceed on data of probabilities, it is, in most instances, a good rule *to wait*. Agnew said 'Often in my professional life, when in a maze of doubt and uncertainty, have I imitated, with the happiest results, the storm-bested mariner, who in the darkness of the night, and nearing an unknown coast, casts anchor and waits for the day. A few hours even, of delay, may open a crevice in a hitherto hidden case of disease, which would be sufficient to illuminate its obscurity and resolve all uncertainties.'

"But when action is called for, let no vacillation spoil your practice; give your whole mind to the case before you, and having judiciously come to a conclusion as to its

nature and requirements, judicially proceed to carry out the decision of your own judgment; do this also with a wise boldness, with a courage tempered with the responsibility of your act, then so arrange your plans that you can carry them out in the simplest way and with the least risk to life. No mere personal preference for, or personal success in, ought to have the slightest influence upon you in guiding your decision; you are to consider your patient's interest, and his alone. Let your practice of surgery be based upon principles, and let your principles of surgery be based upon a higher one, and that higher principle be no less a one than that which binds us all together as men—as Christian men. For if we be surgeons, let us not forget that we are Christian men as well, and let our professional conduct be governed by the same influences that govern our conduct in daily life."

In conclusion may I say how fully conscious I am of the many omissions and defects of this little work, it is of necessity, fragmentary. Its object has been to contrast the ancient and modern methods of trephining. I trust it may be found to represent fairly the existing state of brain surgery, and to establish the principle—that the modern method is "the more excellent way."

"Look not mournfully into the Past. It comes not back again.
Wisely improve the Present. It is thine, go forth to meet
The shadowy Future without fear, and with a manly heart."

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